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TECHNICAL LIAISON IN FORESTRY

One of the criticisms often levelled at Government Departments, and in particular at the scientific officers of those departments, is that of lack of liaison—that the man at one desk does not know what the man at the next desk is doing, that one district is unaware of the work of the next district, and similarly with territories and larger areas. When this criticism is justified it is often due to ignorance of whom to contact and how to do it.

Mr. Swabey, the Chief Conservator of Forests of Uganda, has been kind enough to allow us to comment on his Technical Note No. 6 which was issued in September, 1955, in which he explains in detail to his departmental staff how forestry technical knowledge is passed around. This note was prepared entirely for departmental use and not for general publication.

We cannot do better than start by quoting his opening paragraphs: "For a small technical service it is absolutely essential to maintain liaison with the various bodies working in similar or allied fields. This liaison is necessary not only within the Department but at territorial, regional, Commonwealth and even international levels. This note attempts to show the machinery available for this liaison and how it works. . . .

I consider that it is the duty of all trained officers to take the fullest advantage of the facilities offered for finding out how other people tackle their forestry problems: a parochial attitude of mind is a charge which I hope will never be levelled against this Department."

Mr. Swabey then goes on to details of liaison within the Forest Department itself. It has an annual Departmental Conference of senior officers which deals broadly with policy and technical matters, and a Provincial Forest Officers' Conference which specialist officers also attend. In addition, there is a Forest Department Consultative Council which largely deals with staff matters. Further, to prevent parochialism, arrangements are made for serving officers to visit special work in different parts of Uganda. Recently, a Natural Forest Silviculture Course was held at Mpanda for 26 junior field officers. The department exchanges publications with the major English-speaking forest services, it subscribes to a number of world forestry periodicals, and has an excellent library from which books can be borrowed.

Liaison within the Territory

The Note next goes on to describe liaison within the territory. There is firstly a Natural Resources Committee whose terms of reference are "to keep under review and advise the Minister of Natural Resources on the policy and legislation affecting land utilisation and the conservation and improvement of natural resources and to satisfy itself that policy is being adequately implemented". Under this Committee are at present four subcommittees for Water Resources, for Trypanosomiasis and Game, for Research, and for Education. Examples of the kind of work they do is that the Research Sub-committee deals with research that affects more than one department (e.g., bush reclamation work). The Education Sub-committee is concerned both with advising on extension services from institutes, etc., and also with the integration in the normal curriculum of suitable education on natural resources subjects.

Also affecting the Forest Department is the Husbandry Committee which was set up in 1946 with the object of advising on any problems that affect the relationship of stock and the land, and to keep in touch with livestock husbandry at the various field stations in Uganda. Problems of forest management, conservation of catchment areas, etc., in pastoral areas are therefore of concern to this Committee.

Close liaison is also maintained with the Uganda Development Corporation, as it is investigating a number of possible wood processing industries—in particular paper making and veneer and plywood. Normally the development of processing of forest products (apart from saw milling) would be the concern of this Corporation.

Liaison within the East African Region

Uganda contributes to the various High Commission bodies (as of course do the other territories) and is represented on the various Technical Co-ordinating Committees which

report to the central co-ordinating body, the East African Agricultural and Fisheries Council on which body Uganda has two representatives. As far as the Forest Department is concerned, one of its main contacts is E.A.A.F.R.O. whose forestry staff at present includes a Silviculturist, Assistant Silviculturist, Forester, and Entomologist, and part of the time of a Horticulturist. A Forestry Bureau has been established for the collection, collation and dissemination of forestry information and data of particular concern to East Africa: an East African Forest Bibliography has been published. Research is undertaken into a number of forestry problems and a large arboretum is being established at Muguga. Entomological research includes a general survey of East African forest insects and special studies of economically important species such as *Oemida*, the softwood borer. Valuable hydrological research is being undertaken by the Physics section on the relationships between rainfall, soil, soil moisture conditions and vegetative cover.

This work is discussed by the Forest Research Co-ordinating Committee which normally meets annually and reviews the research programmes of the territories and E.A.A.F.R.O. to ensure proper co-ordination and prevent overlapping, and to discuss any research matters of regional significance. There is a Silviculture Specialist Committee which also normally meets annually to discuss specialist subjects and to report to and advise the Research Co-ordinating Committee.

Although E.A.A.F.R.O. is not a training institution a series of most successful annual forestry courses for professional officers has been held at Muguga and is being continued. It is hoped to speed up this training by short local district nursery courses to include field staff. In addition two Uganda Forest Rangers have undergone training under the Forest Entomologist who directs their work in Uganda. E.A.A.F.R.O. specialists pay periodical visits to Uganda. and as the Technical Note so delightfully puts it "their advice is always welcome and often even followed". Visits of Uganda officers to adjoining territories to study specific technical problems are encouraged.

The Uganda Department works in close botanical collaboration with the East African Herbarium, duplicates of departmental collections go there and much assistance in identification is received.

"E.A.A.F.R.O. deals with forestry research only up to the point of harvesting of the crop and does not therefore deal with forest utilisation matters: there is in fact no regional research on forest utilisation. The East African Timber Advisory Board is a purely advisory body which meets twice a year under the chairmanship of the Administrator of the High Commission. Its membership is now being revised to include representatives of the forest departments of all the territories, of the Railways and Harbours, of E.A.A.F.R.O. and of the timber trade in each territory. It deals with questions of export, freight rates, grading rules, marketing, etc., but has no executive functions. It is now proposed that the Utilisation Officers of the three territories shall become a formal Sub-committee of the Timber Advisory Board to co-ordinate utilisation research and to deal in greater detail with utilisation matters of common interest."

The Uganda Forest Department also works in close collaboration with the East African Statistical and Meteorological Departments largely by supplying essential day-to-day data and by receiving expert assistance when necessary.

Liaison within the British Commonwealth

The Forest Departments of the Commonwealth began to hold conferences in 1920. These conferences are normally held every five years in different Commonwealth countries so that serving officers can see the work and conditions in other parts. It is hoped that it will be possible for the 8th Conference (in 1962) to be held in East Africa—the first time colonial territories will have acted as the host country. These conferences have developed great prestige and have profoundly influenced forestry in the Commonwealth. There is also a Standing Committee on Commonwealth Forestry which meets in London to arrange for the follow-up of resolutions made by the Commonwealth Forestry Conference. The Forestry Adviser to the Colonial Office represents colonial territories on this committee.

With a view to the standardization of research techniques and procedure in forest utilisation, a Standing Committee on Commonwealth Forest Products Research, which includes the heads of all Commonwealth Forest Products Research Laboratories, meets every five years on the occasion of the Commonwealth Forestry Conference.

There are a number of committees that meet in London which review activities in the Colonies, and the Forestry Adviser to the Secretary of State is usually a member when forestry is concerned. In view of Uganda's large-scale work in the poisoning of weed trees, the Colonial Insecticides, Fungicides and Herbicides Committee is of great interest and the Forest Ecologist, Uganda, is their liaison officer.

In addition to the bodies described above, there are a number of committees, bureaux, schools, institutes, and research organizations in the United Kingdom with whom the Uganda Forest Department keep in intimate touch but whose functions are so well known that they should need little elaboration.

The Commonwealth Forestry Bureau, whose function is to review world literature and to publish it quarterly in *Forestry Abstracts*, has become an essential to our technical knowledge. The Imperial Forestry Institute, Oxford, provides post-graduate training for our officers without tuition fees. The Empire Forestry Association to which all our professional officers and many African field staff belong keeps them up to date with Commonwealth Forestry through the quarterly *Empire Forestry Review* which they all receive. The Colonial Products Council largely took over the technical work formally done by the Imperial Institute of South Kensington. Its work is chiefly in the field of minor forest products—gums, resins, tans as well as paper-pulp trials.

The Forest Products Research Laboratory at Princes Risborough is financed exclusively by the United Kingdom and therefore does not normally undertake the testing of colonial timbers unless they are likely to come to the United Kingdom market. A fairly broad interpretation has been put on this policy and a considerable number of Uganda timbers have been and will be tested.

The traditional collaboration with the Royal Botanic Gardens, Kew, on botanical matters continues, and displays of Uganda timbers are maintained in the Economic Museum. The Forestry Commission help to provide visits of staff both African and European to interesting forest projects in Great Britain. The Timber Development Association is entirely a trade organisation and the association arranges visits to interesting forest product organizations in the United Kingdom. Finally, the Forest Air Survey Section of the Directorate of Colonial Surveys is doing its best to help Uganda within the limits of its staff, funds and commitments.

Liaison with International Organizations

The Food and Agriculture Organization of the United Nations Organization includes a Forestry Division which organizes international conferences and publishes annual world forestry statistics and technical reports. The Uganda Forest Department assists in the submission of statistics to the Organization. F.A.O. also organizes technical forestry missions in undeveloped countries, but Uganda is unlikely to be included in such a definition as far as forestry is concerned.

One of the international organizations from which the Forest Departments of East Africa derive great practical assistance is the International Union of Forest Research Organizations. This Organization was founded in 1890 and for a number of years was largely confined to the main European countries where intensive forestry had been practised for many centuries, and to North America where forestry was just beginning. It is only in the last few decades that tropical forestry has found its right place in this Organization for, with the exception of India and possibly Malaya and the Dutch East Indies, it is only in the last few decades that forestry as opposed to forest slaughter has come into being in the tropics. E.A.A.F.R.O. is a member of this International Union whose general functions are to promote international co-operation in the various branches of forest research.

Finally, there is an organization which is international, and yet to us in East Africa also partly local. The Commission for Technical Co-operation in Africa South of the Sahara (C.C.T.A.) was established in 1950, and was the subject of an international agreement signed in 1954 by Belgium, France, Portugal, the United Kingdom, Rhodesia and Nyasaland. Its objective is to ensure technical co-operation between territories for which the member governments are responsible in Africa south of the Sahara. This is achieved by technical conferences, publications, etc., while a number of permanent technical bureaux and sub-committees have been established for specific purposes. There are a number of subjects dealt with by this Commission which are of invaluable interest to the Uganda Forest Department,

such as those in the fields of soil conservation, land use, climatology, hydrology, maps and surveys, etc. The Uganda Forest Department has been represented on the C.C.T.A. Conference of Soils (1948) Forestry (1951) and the Protection of Fauna and Flora (1953).

The above is a rather long description of the mechanics which exist for co-operation in forestry matters and this expression embraces many subjects. We are all scientists working in the same country, and in the same range of fields. It is up to all of us to make the best use of what knowledge exists and of what machinery there is to obtain knowledge that we lack.

It is very obvious from the Technical Note we have been allowed to quote and discuss that the Chief Conservator of Uganda is determined to make the best use of existing knowledge and to be sure that all his officers understand the great value of co-operation and how that can be achieved.

A. L. GRIFFITH.

REVIEW

A Report on Cacao Research, 1954, published by the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, B.W.I., and 40 Norfolk St., London, W.C.2. 1955 price, 12s. 6d.

Definite evidence has now been accumulated which emphasizes the correlation between soil conditions, the vigour of the tree, its fruiting, and its susceptibility to pests and diseases. For example, R. G. Fennah shows that cacao-thrips can multiply rapidly and build up large populations only on cacao leaves in which synthetic processes have been retarded. Cacao leaves produced during the wet seasons on soils of impeded drainage become infested with cacao-thrips; even if the thrips infestation is controlled by insecticide the adverse effects of the environment persist and the trees are unable to improve until these have disappeared with the onset of drier weather. The plant-breeding investigations reported by D. B. Murray and F. W. Cope have the primary objective of finding whether a composite plant yields more than either stock clone or scion clone on its own roots: they found that, as regards early growth, the effect of a clone on growth as measured by girth is generally greater as a scion than as a stock. But the sceptibility of the composite plant to Witches' broom disease and its tolerance to soils of impeded drainage are vital factors in the valuation of new breeding stock, and it is of particular interest that P. Holliday describes a rapid test for the resistance or susceptibility to Witches' broom disease. The testa is removed from the ripe seed which is then placed to germinate on damp filter paper. After four days the seed is inoculated with spores of the disease and is then planted in potting soil. Susceptible seedlings show signs of the disease within a few weeks.

In his fourth paper on the interactions of shade and fertilizers on the growth and fruiting of cacao, D. B. Murray describes what happens when trees formerly grown under varying amounts of shade are now grown in full light. Whilst the removal of shade led to an immediate loss of leaf, within six months the trees had produced sufficient new growth to form closed canopies, and plants which had previously grown in heavy shade produced practically double their former crop.

Since some 12,000 rooted cuttings for estate planting were produced during the year, a problem arose when many of these had to be held in the hardening shed until they became lightly infested with various pests. R. G. Fennah found that exposure to 30 gms. of HCN per 1,000 cubic feet at a temperature range of 86°F to 89°F and a relative humidity of 80–100 per cent caused no injury to the plants and resulted in 100 per cent kill of insects tested and 70 per cent kill of millipedes. At double the concentration of HCN all arthropods were killed but some damage was sustained by the plant. With methyl bromide the gap between toxic level to invertebrates and the threshold of damage to the plants is so narrow that this fumigant could not be recommended, and a BHC smoke at heavy dosage failed to give control of mealy bugs.

D. W. D.

NOTES ON ANIMAL DISEASES

XXVII—PROGRESSIVE (ENZOOTIC) PNEUMONIA OF SHEEP IN KENYA

Compiled by the Department of Veterinary Services, Kenya

(Received for publication on 24th December, 1955)

Notes on Animal Diseases No. XVIII issued by the Department of Veterinary Services gives a concise, if brief, account of the various types of pneumonia to which the sheep is subject in Kenya. A form of pneumonia known as Laikipia lung disease has been known since the early days of sheep farming in the Colony and its high prevalence in the Laikipia area, which then was the main sheep-raising district, earned this title for the disease. During succeeding years it was apparent that as sheep farming intensified in the Colony the disease became widespread, very few flocks being unaffected in some degree. This situation led to an inquiry into the nature of the cause of the disease and in 1929, published results of the laboratory and field investigations claimed the disease to be bacterial in origin. This discovery was soon followed by the production of a killed vaccine prepared from the organism. The vaccine was widely used during the next few years, but, by 1936, it was becoming apparent that it was not effective in controlling the disease in affected flocks; during this year, a survey into the problem of sheep pneumonia was inaugurated and this continued for the next two to three years. From this work emerged the findings that there exist several forms of sheep pneumonia in Kenya, all classified loosely as Laikipia lung disease and all capable of causing serious losses on sheep farms, viz. Laikipia lung disease proper, as originally described in 1929, Jaagsiekte or chronic progressive pneumonia, septic broncho-pneumonia due to organisms of the Corynebacterium group and, of lesser importance, parasitic pneumonia due to the specific sheep lung worm. Pathological studies in Laikipia lung disease generally led to the conclusion that the underlying cause was a filterable virus and that the bacterium previously claimed as the direct cause was merely a secondary invader, and responsible for the lung abscesses fairly frequently seen on autopsy.

The advent of the Second World War and serious shortage of qualified staff at the laboratory prevented further prosecution of this valuable research. In the meantime, the Laikipia lung disease vaccine was issued as a routine product pending a continuation of the research at some future date. However, it was not until 1952, that this project became possible, and during the intervening years Laikipia lung disease took its annual and often heavy toll. From this year research centred on sheep farms in the Laikipia area, extending gradually to farms in the Timau, Nyeri, Nanyuki, Naro Moru, Ngobit and Thomson's Falls districts. The disease has also been detected on farms in the Molo, Njoro, Elmenteita, Naivasha and Kinangop districts where, however, it is not so rife nor so much a cause of serious mortality as in the districts first named.

Laikipia lung disease has a close affinity, on pathological consideration, with Jaagsiekte and with a form of sheep pneumonia which is enzootic in America, known as Montana sheep disease, and an analagous disease, "La Bouhite", occurs on sheep farms in France; a similar disease of sheep styled "Maedi" has been responsible for disastrous losses in Iceland, apparently having been imported from Germany. "Pulmonary adenomatosis" of sheep in Peru resembles the Jaagsiekte disease of South Africa and the latter has recently made its appearance in sheep in the British Isles. So-called Laikipia lung disease of sheep is, then, not peculiar to Kenya. In recent correspondence with one of the world's leading authorities on sheep pneumonia in America the opinion is given that those forms of pneumonia just enumerated are variations of a disease with a specific pathology, and of common causation, the various types of this disease seen in sheep populations in different fields being due to variations in the levels of susceptibility in such populations.

Jaagsiekte has been known in Kenya flocks since 1933 and was probably imported with Merino sheep from South Africa where it has caused such devastating losses as to necessitate, in the worst affected areas, a slaughter policy of eradication. Intensive research on this disease has been conducted for several decades in South Africa and although the clinical and

pathological features of the disease are well described in published reports the cause still remains baffling, and no method of control by vaccination is known.

The writer of this note is of the opinion, founded on close studies on the pathology of Laikipia lung disease, that it is a variation of the classic type Jaagsiekte, and that any bacteria that can be isolated in such studies are essentially secondary invaders, though, when present, they are apparently responsible for the abscesses which are occasionally seen in frank cases of Laikipia lung disease. It should be noted, in this connexion, that in the majority of lungs affected with the disease no bacteria of potential pathogenic significance can be isolated, which fact at once rules out the possibility of the disease being of bacterial origin.

During the earlier survey on the problem already mentioned a filterable virus was suspected as the cause of the condition, and the present research supports the opinion. A virus of large size has been recently isolated from early lesions in the affected sheep lung and can be successfully and apparently indefinitely propagated in the yolk sac of seven-day embryonated hen eggs. Experiments are still in progress to determine whether and by what method this virus can reproduce the typical disease in fully susceptible sheep. That the virus possibly has a direct relationship with the disease is shown by serological tests, viz. the complement fixation test using an extract of yolk sac and serum from a diseased sheep.

That the disease is highly infectious is beyond all doubt. The system of close sheep *bomas* wherein sheep are huddled during the night for protection from marauding animals accounts for a rapid spread of the disease to lambs and to older sheep that have so far withstood the ubiquitous infection; and it may be that sheep which would otherwise have picked up a mild and perhaps well-tolerated infection (due to lesser susceptibility) are overwhelmed by repeated massive reinfections. Hypothetical though this last consideration may be, the fact remains that when the system is abandoned the incidence of disease in sheep of all age groups undergoes a steep decline. The annual loss on affected farms averages 25–30 per cent and this has crippled the sheep-farming industry in Kenya to such an extent that many farmers have abandoned keeping sheep on a large scale.

Although the disease is so obviously infectious in the field it is difficult to transmit it to sheep under controlled experimental conditions. It attacks clean sheep introduced into infected flocks, once again proving its infectious nature, yet when clean susceptible sheep are intranasally sprayed under high pressure with an emulsion of freshly diseased sheep lung they resist the infection, and equally, it does not appear possible to reproduce the disease in suitable experimental sheep by the intratracheal inoculation of similar lung emulsion. The disease has been reproduced in Kenya sheep by the subcutaneous inoculation of such emulsion, with an incubation period of four to six months. Also, recent work shows that sheep may be fairly readily infected when fragments of fresh diseased lung are incorporated in an agar plug which is then introduced into the lung by the jugular vein route; here again the incubation period is about four to six months. Sheep may also be infected by direct inoculation with the emulsion into the lung. Attempts are in progress to reproduce the disease in sheep with the virus isolated in eggs.

The disease is easily recognized on clinical grounds. The respiration rate is increased and hurried, especially as sheep are driven, when paroxysmal coughing may be noted and such animals always lag behind when the flock is moved and are generally in poor condition. Affected sheep may live for many months; periods of up to two years have been observed. The pneumonia is slowly progressive, and radiography is of considerable value in detecting early cases and in observing the progress of the lesions of the disease. This fact might be of importance in preventing the importation of sheep into clean areas when X-ray facilities are available. There is slight nasal discharge in pneumonic cases although the prevalence of nasal fly in Kenya flocks is responsible for a sticky discharge which somewhat complicates the picture. Autopsy shows that the lungs, of which one may be more affected than the other, do not collapse when the chest cavity is opened and usually there are firm adhesions to the chest wall. The affected lung weighs two to three times the normal. It is solid, fibrous and largely transformed into tumour-like tissue, greyish in appearance. If the anterior and middle lobes of the lung are mainly affected and the posterior lobes relatively normal, tumour-like patches of tissue can be seen invading the still functional lobes, gradually coalescing to a

uniformity of the lesions throughout all lobes. Fluid is present in the chest cavity and often the heart sac is swollen and jelly-like, as is the mediastinal tissue.

Research is too recent to arrive at a definite opinion of the nature of the infective agent and when this is firmly established it is hoped to produce a virus vaccine.

An early pilot experiment showed that lambs withstood the subcutaneous inoculation of diseased lung emulsion over a period of 30 days' observation and it was then thought that such might be useful as a vaccine. It was not known then that the experimental disease has a very long incubation period and the method was given a field trial. A considerable number of three-month-old lambs was inoculated subcutaneously, each with 2 ml. of a fresh lung mash diluted in salt solution. The lambs were placed in isolation and about six months later a number were showing signs of early disease; within a year all were affected and deaths starting. There were few survivors in this disastrous trial. The next step was to add 1 per cent commercial formalin to such a lung suspension and with this several hundred lambs were vaccinated at one week, one month and three months old, leaving an equal number of unvaccinated lambs of the same age as controls to the experiment. The results exceeded all expectations. Deaths in controls, over one year's observation occurred with the usual regularity up to 30 per cent whereas in vaccinated lambs deaths were approximately 1 per cent. These results have been repeated over successive years since 1952 and the incidence of the disease on affected farms has been very materially reduced, even when obvious lungers which are notorious spreaders of the infection have not been culled. It seems evident that this experimental vaccine has proved of real value in controlling the high incidence of the disease on stricken sheep holdings. It is advised that lambs be vaccinated at one month and again at three months of age. The objection to wholesale vaccination of the flocks is that many of the older sheep will be affected in some degree and doomed to die in any case, and discredit might in consequence be attached to the vaccine through a failure, which should be expected, to give a wholesale protection. If this consideration were duly appreciated the objection could be raised. The rationale of vaccination is to build up disease-free flocks from lambhood. How often vaccination should be practised is not known but once yearly is advised at present.

In conclusion, outbreaks of "pyogenes" pneumonia in sheep have not been encountered during the present survey and the incidence of parasitic pneumonia is likewise negligible. The only form of pneumonia of significance that has so far been detected in the present survey is that now described.

CONTROL OF THE SUDAN DIOCH OR RED-BILLED FINCH IN TANGANYIKA

By J. W. Haylock and H. J. de S. Disney, Department of Agriculture, Tanganyika, and R. E. Rapley, Colonial Insecticide Research Unit, Tanganyika

(Received for publication on 15th December, 1955)

Quelea birds (*Quelea quelea æthiopica*) have been a problem to agriculture throughout eastern Africa for many years, doing enormous and widespread damage to African crops of sorghum, millet, eleusine, rice and other small-grain crops. During the past 15 years increasing damage to wheat and barley crops has been suffered both in Kenya, where, in 1952, 100,000 bags of wheat were estimated as destroyed, and also in the Northern Province of Tanganyika. While the attacks on the wheat crops have not been annual events, it has been noticed that the frequency of visitations to the wheat areas has been much increased in the last 15 years. It cannot be appreciated just how much damage is done to all crops annually until such time as an accurate district by district estimate has been compiled for both countries.

In the past no effective control was feasible by the European and African farmers, except where cultivated patches were sufficiently small to be guarded by children. In the case of more than an acre or two, crops are wiped out by the persistency of the diochs and their ability to become quickly accustomed to noise and disturbance.

Various individual efforts have been made, either by groups of farmers or native authorities when infestations were very bad; the use of traps and the cutting down of breeding colonies in Central Tanganyika has been carried out by the natives for many years.

In 1948 an extremely bad attack developed on the western Kilimanjaro wheat lands and farmers endeavoured to save their crops by poisoned water, birdlime and the mass shooting up of a roost by a number of guns. The burning up of the birds with petrol in their roosting and nesting sites was tried.

The Government has been closely interested in the matter and from 1952, when the Agricultural Department initiated an investigation of the problem of control, much has been learnt by the realization of the immensity of the damage to crops involved and by the study of the habits of the birds and their control. However, much still remains to be learnt.

Quelea are extremely gregarious in habit. They form into densely packed night roosts, wherein literally millions of birds congregate together within a few acres (the density varies with the type of roosting bush, tree or tall grass) and in the breeding season form vast "slum" colonies, where as many as 500 or more nests per bush occur. The colonies vary in size from a few acres to many square miles, and are usually in uninhabited *Acacia* country. It is obvious that these roosts and breeding colonies offer the best prospects for control of the birds and so far have proved most vulnerable.

Much thought has been given to the problem and numerous suggestions have been made. A variety of field and laboratory tests have been carried out, and a summary of a few unsuccessful, as well as successful, methods of control is now presented in the hope that it may assist others working on the same problem, while saving some wasted effort in the search for the "complete answer".

Birdlime.—The use of birdlime in various forms has been tried on several occasions. Banding-grease pasted on bush surrounding feeding areas has had some success as it only needs a very small spot on the plumage to "ground" the birds. The possibility of diluting some form of birdlime in a highly volatile base has been tried, as it was suggested that "liming" large areas of resting bushes and roosts, either from the ground or air, might be effective. Unfortunately it was found that to dilute sufficiently to spray, i.e. 7 lb. "Dak" rat lime to 2 gal. petrol, the mixture would not stick to the bush and required an exhorbitant quantity for even small bushes.

Lime is quite useful for the collection of small numbers of birds for experiments.

Molasses.—One of the first organized control efforts in 1953 was the spraying of a particularly favourably sited roost with molasses. The roost was located in bush in a depression which could be approached by tractor. A power pump was used for spraying a mixture of 100 gal. raw molasses mixed with 30 gal.

water. Many applications of this from all sides gummed up tens of thousands of birds, which subsequently died. Since that time no roost suitable for this type of spraying has been found. This method is also cumbersome as much material has to be taken into very difficult country.

Bird Scaring.—The numerous methods of scaring by natives equipped with various types of noise-making appliances, such as rattles, sirens, etc., are useless on even a quite small patch of grain. The birds soon become used to all kinds of banging, explosions and shouts, and move just out of range of stone throwing.

Shotguns.—These are virtually of no use as the few birds killed, compared with overall numbers, are not significant. The birds soon get quite accustomed to the bangs.

Acetylene Scarers.—These make an explosion every minute or two and are only effective within the immediate vicinity; moreover, they are only effective for a few hours until the birds get used to them.

Aircraft.—Nesting sites can usually be spotted from the air, but not until the grass of the nests has turned brown to contrast with the leaves of the trees. It is also possible to see if the nests have been completed and if there are any birds about.

Planes flying low over the fields keep the birds on the move, but this form of control would not be economical, and, further, the birds would probably become accustomed to the noise of the aircraft after a short time.

The Supersonic Field.—This has been explored and as most bird's hearing range is within that of humans, any sound disturbing birds would also disturb humans and stock. The physics of sound transmission is considered by the United States Department of the Interior to eliminate any chance of it being economical over a large area.

Recording and Amplification of Alarm Calls.—This has been considered, but it is not yet known what the alarm call of the dioch is. It may possibly be the noise of the wings rather than the call. Mr. Myles North reports that—"reproducing a starling's alarm call by a loud speaker at a London roost was immensely successful *once* but then never worked again".

Falcon Perches.—Usually attendant on bird concentrations are many predators, such as hawks, eagles, etc. There has been no need to erect perches as natural resting places are plentiful. *Quelea* are not very scared of the larger birds of prey and resume feeding immediately after an attack. The number of birds taken in this way is completely insignificant. The flying of artificial predators, e.g. fabric kites, has been tried without avail.

Explosives.—The use of explosives in themselves has been surprisingly disappointing under conditions in Tanganyika. To obtain a near-total kill in the roosts would require such a weight of explosives as to make the operations quite uneconomical. A suggestion, which might have got over the expense of explosives, was that all "time expired" naval depth charges be obtained from the Navy and exploded simultaneously. The resultant blast would be terrific and should have satisfactory results in certain uninhabited areas. Technical difficulties prevented this suggestion being put into practice.

Sand Bombs.—Some success was achieved, and in one case a spectacular kill was obtained by attacking roosts with these bombs. Traces were prepared at suitable intervals throughout the roosts, according to the density of bush, and bombs consisting of 14 sticks of 60 per cent gelignite, charged with 40 lb. of coarse river sand and/or aggregate, were placed in stout paper packets suspended from poles or in the actual bush. Others were sunk into the ground to give a sawn-off shotgun effect. All charges were connected with instantaneous fuse and as many as 400 detonated together. Results were fair, as already stated, and many birds which were not killed outright died away from the roost next day, having been punctured by the sand. This method is similar to that used in the United States in the control of winter blackbirds' and crows' roosts, where dynamite bombs loaded with shot and shrapnel have been tried with some success.

The preparation of this type of attack is vast and complex and it has been found that where the work took more than a day there was a very great danger of the birds deserting the roost, thus rendering the effort useless. In some roosts the density of the bush caused comparatively small kills.

Fougasse Mines.—Engineers from East Africa Command kindly supervised the laying of 10 fougasse mines, which consisted of trenches cut into the ground and aimed at the main roost. The end of the mines were about 4 ft. across and charged with 40 lb. of ammonal, each detonated by a gun cotton primer and exploded by instantaneous fuse connected with an electrical detonator. Over

and in front of the ammonal was placed 1,000 lb. of iron filings and aggregate and the trench broadened out up to 7 ft. This gave a broad sweep of fire and coverage. The explosion resulted in a very poor kill as the thickness of the bush protected the birds.

Fire Bombs.—Work was carried out on the exploding of small petrol bombs, but, owing to the lack of experience, field trials were poor and the idea was dropped for a time. After various other methods had been proved useless or too difficult, another attempt was made to obtain this end. The technique now described is the result of numerous experiments and trials in the field and is easily the most efficient and easily prepared method for roost destruction that has been evolved up to now. Really first-class results have been obtained, averaging 80 per cent to 90 per cent of the bird population of an area destroyed at one stroke.

After a roost is discovered a reconnaissance by crawling through on hands and knees will soon show the exact size of the area by the masses of droppings. Depending on the density of the bush, small traces are made to enable explosives and fuel to be placed. These traces vary between 18 and 25 yards apart, and the spacing of the charges is staggered in the traces at the same intervals.

The following stores are required for the operations, the cost being up to £75 per acre:—

(1) Sufficient 44-gal. drums (discarded by the oil companies and bought for from Sh. 3 to Sh. 5 each). Care must be taken to see that they are tight and all holes welded up.

(2) Sufficient 40 per cent or 60 per cent gelignite to enable 10 lb. of this per drum and complete 50-lb. cases per six or seven drums of fuel.

(3) A 50-50 mixture of petrol/dieselene is then put in the drums at a rate of 30 gal. per drum (the oil company will arrange to fill the drums with this mixture, which saves a lot of time and trouble).

(4) Enough instantaneous fuse, either Primacord or Cordtex, to complete the layout of the circuit, allowing for *extra* connecting lines joining all main lines, so that firing impulse passes in all directions and bypasses any breaks and short circuits.

(5) Enough cellotape to make all fuse connections secure, even in damp conditions and rain.

(6) Safety fuse and standard-type detonators for firing the instantaneous fuse.

In some roosts a small tractor and buckrake are very useful in placing the drums *in situ*, but in most cases the drums have to be manhandled into position, usually with great difficulty in steep gullies or hillsides. This would indicate that a smaller drum of 30-gal. capacity would be the most useful, but these are unfortunately not available locally at a cheap cost.

The drums having been placed, small holes just sufficiently large for a 10-lb. gelignite packet are made in the ground and the packet is torn and a few sticks of explosives are taped to the knotted instantaneous fuse. The drums are then placed in direct contact with the charge, usually half of them being on end and half on the side. The earth is firmly clamped down and care must be taken that the fuse is buried slightly in the ground to avoid bruising and possible "shorts" when the drum is placed over it.

The whole circuit is then brought to the firing point, where it is preferable to have two lengths of safety fuse (long enough to enable the operator to get at least half a mile away) fixed into standard detonators and strapped securely to the end of the instantaneous fuse. The entire layout is then camouflaged with branches and bush, and the two equal lengths of safety fuse are lit sometime after the birds have settled down for the night.

The resulting flash and explosion is most spectacular and the roost becomes a raging inferno with a most impressive atom bomb effect and a Bikini cloud rising to a thousand or two thousand feet. The actual flash lasts several seconds and the area then becomes a mass of flames; as many as 47 drums are exploded together, but the number depends on the size of the roost. Millions of birds can be destroyed and masses are reduced to almost unidentifiable ash and thousands literally blown to pieces. A drawback to this method is the stragglers roosting outside the bombed area are badly wounded and take a day or so to die.

It is essential that all work is completed in one or at the most two days, which is quite possible for one European and 40 to 50 natives in most localities.

The Army allowed us to have some 20 44-gal. drums of written-off flame thrower

fuel, which was exploded in some of the above-mentioned explosions. It was found to be successful and almost equal to other fuel used.

Flame Throwers.—Army flame throwers capable of initial wet squirts subsequently ignited by flame squirts were tried. These proved no use in roosts as their performance was poor and they were considered out of the question for bird control. On the other hand, simple, easily operated lance throwers have been put to use, consisting of a stirrup-pump connected by a length of rubber hose to the flame lance, with a 4-gal. can of dieselene. The lance is up to 6 ft. long and has a copper cone to prevent extensive heat returning to the operator. Surrounding the nozzle on a wire frame is wound asbestos string which, when soaked in dieselene and when the pump is in action gives the jet of fuel its ignition. The jet of flame carries up to 20 ft. and gives an intensely hot searing flame. This model is used largely or rather exclusively on breeding colonies, which are usually constructed in dense "wait-a-bit thorn" (*Acacia mellifera*) with up to 500 nests or more per bush or tree. There are usually between 20 and 100 bushes per acre, the average being about 60 to 70. This flame thrower is easy to handle and is more reliable and manageable than more complex machines. It is easily repaired and operated by natives and can be moved around even in dense bush. It has been entirely successful in the destruction of breeding colonies and uses only 44 gal. of fuel per 5 acres or more, or rather less than Sh. 100 of material to destroy up to 30,000 young birds. The mortality of adults is very low, even using this technique at night, owing to the roaring noise made by the flame.

When a colony has been discovered and the time has arrived for destruction, the following organization is required. Fuel is taken to the nearest point and distributed at convenient intervals throughout the area. This is to enable carriers to minimize time wasted between thrower and fuel dump. Throwers are operated by two people, one pumping and one burning all the nests. The carrier's duty is to keep sufficient fuel available to avoid delays, and this is quite easily accomplished if the fuel dumps are well sited. Ten throwers working for 11 hours a day can cope with approximately 100 to 150 acres according to bush density. It is imperative that all nests are completely burnt out, as *Quelea* are most persistent parents and will continue to feed their young even when they are in charred and half-burnt nests.

The choice of fuel was made after various experiments and apart from being safer than the volatile fuels, gives the better flame and is, of course, more economical.

It is important that close control of the operation takes place. Operators are inclined to lose sense of direction and meander about unless controlled and told what to do. This means a great waste of time, as one has to return to small pockets all over the place for mopping up. The use of a bulldozer, if available, is invaluable in cutting traces and thereby helping direction keeping.

Traps and Nets.—The uses of traps and nets have been studied (*a*) to see if control could be effected, (*b*) in catching specimens for laboratory tests, and (*c*) for ringing and dyeing. Nets seem only useful in catching small numbers for a specific reason, as although fair numbers can be caught in the Spanish sparrow net in certain types of roost (long Napier grass) the use of nets is not feasible for control. Traps constructed of half-inch wire netting and baited with grain after a harvest, or water in a dry region, can catch a thousand or even two thousand birds an hour. Small inlet funnels are used with a large funnel (closed when trapping) to assist in removing the birds in a cage. These traps are useful in a ringing campaign, but are only really effective in either dry regions or where no grain is available in standing crops or grasses. In certain desert regions where small water-holes are used by millions of birds, a fair measure of control might be had by completely caging in the water supplies over large areas and trapping and killing the birds.

Chemical Control

Work has been carried out by the Colonial Insecticide Research, Arusha, in an attempt to find suitable chemicals for the control of *Quelea*. It has seemed obvious that to overcome the problem within a short period and at an economical figure it is essential to discover suitable chemicals for use both from the air and the ground, for attacks on roosts and breeding colonies. Research has, therefore, been carried out along these lines and also to find poisons for the baiting of food and water, in addition to standing crops.

Poison Baits.—Early attempts at baiting *Quelea* were not very successful. Farmers on their own initiative laid out small artificial

watering points around and within their grain crops which were subsequently heavily poisoned with arsenite of soda. Birds did succumb in their thousands and although apparently not alarmed by their dying comrades for a short time, did avoid drinking at these points quite quickly. The numbers killed in this manner were but a "drop in the ocean" compared with the numbers present and the risks attached to this method are not considered worthwhile, where numbers of natives are present. Sodium cyanide, which quickly hydrolizes, has been tried in water-holes and does kill the birds.

Although the results to date have been poor, water poisoning must still be kept in mind. It has good possibilities if used intelligently in desert regions where *Quelea* might be attracted to artificial watering points in tens of millions.

Several poisons were tried in the laboratory for the possible control of *Quelea*, either by laying poisoned grain, or for the possibility of spraying a bait crop of some grain more attractive to the birds than wheat, or for spraying the wheat itself at a safe period before the harvest.

Although there are several very promising poisons which the birds will take under laboratory conditions, there has so far been little result in the field. The quickest-acting poison tried was strychnine hydrochloride. At 1 part to 1,000 of dry wheat it was lethal to the birds, and at double the strength, i.e. 1 to 500, the birds were killed almost immediately. In the laboratory the birds ate just as readily from the grain treated with strychnine as from the untreated grain in the same cage.

Arsenic was tried as arsenious oxide and sodium arsenite, but both were very slow in action and needed as much as 4 per cent mixing with the grain to gain a complete kill. Of the two, arsenious oxide gave a slightly better result.

Three organo-phosphorus compounds were tried as bait poisons, all of which were extremely poisonous to the birds. The most toxic was Paraoxon, which was lethal to the birds when mixed with their food at the rate of five parts per million. However, even at that low concentration it appeared to be obnoxious to them. Parathion and Schradan, the other two compounds tried, were less toxic, but did not appear to be as obnoxious, although 1 part of Parathion per 1,000 of grain and 20 parts of Schradan per 1,000 were necessary for a kill.

DDT, BHC and Dieldrin were all tried as bait poisons, but none showed toxicity even at 5 per cent W/W.

From the results obtained in the laboratory there is a good choice of poisons which are effective if sufficient numbers of the birds can be persuaded to consume a poison bait to make the precautions worthwhile. Although strict control of the material is necessary and essential, strychnine appears to be the poison of choice for a dry bait, and Parathion for spraying within a bait crop or the crop itself. With regard to strychnine, the United States Department of the Interior, Fish and Wildlife Service report that chickens, turkeys, grouse, quail, partridges and pheasants are more resistant to it than any of the small species.

The great difficulty with ground bait is the birds' preference to feeding from standing crops, and foraging on the ground only for grit and for food when there is literally none other available for miles.

Gases.—The only gas tried in the laboratory has been HCN liberated from Plant Protection's "Cymag"; this was found to be immediately fatal to caged *Quelea* in a concentration of 1 part HCN in 640 parts of air.

The difficulties in the use of any gas in the field are very numerous. It has been estimated that an area five miles downwind of the treated area would have to be evacuated of all persons and domestic animals, with emergency arrangements for further evacuation in the event of a change of wind.

The concentration/time product for HCN which has been suggested is 500–750 mg/cub. metre/min. This would require 10–60-lb. cylinders for a 20-acre site.

Phosgene has been suggested as a possible gas for use against the birds. It has not been tried owing to non-availability but the concentration/time product suggested has been 1,000 mg/cub. metre/min.

Less poisonous substances have also been tried under roosting birds to see their reactions. Sulphur burnt in the same manner that poachers use under roosting game birds did not overcome them, nor did tear gas grenades set off under them appear to trouble them in the slightest.

Contact Poisons.—In laboratory tests .025 ml. of 20 per cent DNOC applied to the feathers was found to be fatal. In the field however DNOC applied to a roost by means

of a TIFA appeared to be completely ineffective; as indeed was a similar attempt at roost destruction with an organo-phosphorus compound applied through the same machine. However, the heat generated by the TIFA severely reduces the toxicity of organo-phosphorus compounds.

It was reported by workers in the United Kingdom that 35 mg. of 5 per cent. Parathion dust applied to the birds was fatal. The first test in Arusha showed that rather more than 35 mg. were required to give a rapid kill. However, 50 mg. killed all birds in 20; later work showed that as little as a single dose of 0.5 mg. of pure Parathion did eventually kill the birds, and although in cages it took 48 hours for them to die. They were so sick after 24 hours that in the field they would have been incapable of flight.

The main difficulty in the use of Parathion in the field, particularly with dusts, is the hazards to the operators, and as yet no safe way of applying the poison is available.

As Malathion is considerably less dangerous to man it was tried against the birds, but as 5 mg. of the compound failed to kill the bird it was not investigated further.

Paraoxon is considerably more toxic to both man and birds, but no exact figures are available as to the dose required for killing birds, as the only sample available to us was in all probability partly decomposed. This compound has also the advantage of less persistence in the field and would, therefore, require supervison of a treated area for less time than Parathion.

A field trial was attempted with 5 per cent Parathion dust, but was not conclusive as there were a number of technical errors.

It has been reported by workers in Senegal that successful trials in the control of grain-eating birds have been made using Aldrin as a control poison. This compound along with Endrin and Isodrin were tried in the laboratory and it was found that 2 mg. of Aldrin, or 1 mg. of Endrin or Isodrin gave a complete kill in 24 hours. In view of this the manufacturer's representative was contacted to obtain a quantity for a field trial. Unfortunately the only formulation of any of these compounds available in East Africa in solid form was 30 per cent Aldrin wettable powder. For the two field trials carried out this was diluted with micro-pulverized talc to 10 per cent Aldrin content.

For the first trial cages of birds were placed in a typical roost site, and the dust applied by a Junior Whirlwind Duster, to give an estimated dosage of 50 mg. of dust per bird in one trial and 25 mg. of dust per bird in another. Sticky papers were placed by each cage for the collection of samples for chemical estimation.

From chemical results obtained it was quite obvious that the active ingredient of the dust, being finely divided, was carried away by the wind and the heavier talc was dropping on the sample papers which appeared to be well coated with dust.

Apart from one cage of birds which received the full force of the blast from the duster, the birds continued to die for 10 days after the experiment in a very haphazard manner so that no useful data was obtained.

A trial was conducted with the same dust on a nesting site at Nguruka, in this case the dust was applied by a Junior Whirlwind Duster to the individual bushes. Young birds were hopping from branch to branch at the time of the dusting and though there was no apparent reduction in the population in the bushes, chemical analysis again showed a very small deposit on the nests, therefore, it appears that the light active ingredient was again carried away by the wind.

Reports from the United States Department of the Interior, Wildlife Research Laboratory Colorado, state that they had had a report on an experimental crop dusting with Parathion, when many of the birds attacking the field, caught in the dust cloud, were killed. Another phosphate, tetraethyl pyrophosphate, which is extremely hazardous, has been used in cage tests and it was found "that birds which perch on a perch treated with this material, 5 per cent in an oily base, drop off dead very shortly".

Aerial Spray with DNOC.—A field trial was carried out against a breeding colony in rather scattered bush, using DNOC at three rates of application. This trial was unsuccessful as the best result achieved was only a 33 per cent kill. The application rate of 10 gal. per acre, at a time when the young were out of the nests and fluttering about and were most vulnerable to this form of control produced the best kill, but owing to the cost and poor results the experiment was not repeated.

Repellants.—At the present there seems very little hope of the successful use of repellants.

Left:

Fig. 1.—Queleas flighting into roost.

Right:

Fig. 2.—10-acre blow-up taken 1½ miles away.

Left:

Fig. 3.—Random count after blow-up. Each heap contains 1,000 birds.

[*Photo*: *E. Wallace*

Mercaptobenzthiozole and anthraquinone have been mentioned and the latter has been fed to birds in cage tests, in various formulations and strengths, but the birds have shown no preference to untreated grain as against treated grain. In any case the use of repellants would only be of use on seed crops as nothing as yet is known here of any chronic toxicological hazards or tainting which might occur on grain so treated.

Knock-out Drops.—The only one tried was a French preparation called "Corbodor" which renders birds unconscious in a quarter of an hour for a period of one hour. This method might be useful in collecting birds for experiments.

Conclusions

It will be seen that work has been carried out along several lines, but so far the only really successful methods that can be reported are:—

(*a*) *The Fire Bomb.*—This method for roost control, whilst being expensive and having severe limitations, is of much value when birds are causing damage to a crop in a particular area.

(*b*) *The Flame Thrower.*—This technique, which can be used more extensively and economically for breeding colonies, also suffers from limitations (moving of materials into sometimes "impossible" country in time to prevent the young from flying). However, it has proved very useful in that all young can be destroyed at a moderate cost.

Both methods, as already stated, are the best available but are by no means ideal. It must be emphasized that what is required is some form of chemical suitable for application from the air and the ground, whereby breeding colonies may be attacked and both young and adults destroyed. Roost destruction in inhabited areas offers a greater problem. Apart from operation hazards, there should not be an after-hazard of more than a day or so to stock or humans who might wander into the area, as it is almost impossible effectively to close and seal large areas for more than two days, under the conditions pertaining in inhabited areas.

Research must go on to find suitable and relatively safe control methods, and close co-operation must be sought from all workers on the problem of *Quelea* throughout East Africa whose countries suffer from the severe depredations of these locust-like birds.

RELEASE OF NEW CEREAL VARIETIES—1956

By H. C. Thorpe and G. E. Dixon, Department of Agriculture, Kenya

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The undermentioned cereals have been released by the Department of Agriculture for sowing during the 1956/57 season. In conformity with established procedure the varieties have been tested in trial plots on the Plant Breeding Station and district stations, and subsequently with farmers in various parts of the country.

Wheat 356.A.2.A.

This is a further selection from the cross 184.P.2.A.1.E x 192.Q.2.A. (L) made at Njoro in 1944 and is a sister strain to 356.A.12.C released in 1955.

356.A.2.A is a beardless, white-chaffed, white-grained variety of mid-season maturity, fair straw strength and fair baking quality. It is resistant in seedling tests to forms K9–K12 of black stem rust, but shows susceptibility to the newer forms, K13 and K14. It was, in fact, attacked by stem rust and damaged to some extent during final multiplication in 1955. The variety possesses resistance to orange leaf rust, and to yellow ear rust up to about 7,500 ft. in Kenya. It takes roughly five months to maturity, depending on altitude and climatic conditions.

356.A.2.A has yielded reasonably well during multiplication in the Endebess and Kipkabus areas. In spite of the fact it did rust fairly extensively last season, it is felt that this variety may still have value at least for some little while and it has therefore been decided to proceed with its release as originally planned.

In order to avoid confusion, the earlier strain, 356.A.12.C, will in future be known as 356.A and the present 356.A.2.A as 356.B.

Wheat 358.AA.5.B

This is the first of a new series of wheats from the cross 184.P.2.A.1.E x 294.B.2.A.3 developed at Njoro.

It is a bearded, white-chaffed, and red-grained variety of mid-season maturity and fair straw strength. Although its reactions to stem rust are not yet known, the variety proved resistant in the field during multiplication. It shows resistance to orange leaf rust and to yellow ear rust up to 7,500–8,000 ft. in Kenya. It takes roughly 5–5½ months to maturity depending on altitude and climatic conditions.

358.AA.5.B has proved exceptionally aggressive and has yielded well during multiplication chiefly in the Njoro area.

Wheat 362.B.1.E.4

This again is the first of a new series of wheats derived from the cross Equator × 294.M.7.C.6.C. and developed at Molo, 9,200 ft.

It is beardless, red-chaffed, red-grained variety of latish maturity and good straw strength. Its reactions to stem rust are not yet known but it has been somewhat rusted in most years during multiplication. It shows resistance to orange leaf rust and to yellow ear rust up to 9,000 ft. in Kenya. It takes roughly 6½ months to maturity at that altitude.

The 362's are essentially high-altitude wheats, and several further selections are due for release after a further year of multiplication. This particular strain, B.1.E.4, has shown itself capable of yielding well both at Molo and at Ndaragwa (Thomson's Falls). It is hoped that the rust susceptibility will not prove a serious drawback at the altitudes best suited to this variety.

Carlsberg Barley

Carlsberg is a two-rowed Danish barley of good straw and grain quality, derived from the cross Maja x Prentice. Although not so high-yielding as the more aggressive Scandinavian barleys of the Herta and Abed Kenia type, Carlsberg has nevertheless yielded well. It is suitable in Kenya to the 7,000–8,500 ft. altitude range with a growing season of some five to six months.

Carlsberg is judged in Europe to be the best of the Scandinavians for malting purposes. The two earlier releases, Herta and Kenia, are not very suitable for malting (especially the former) and it is hoped that Carlsberg will prove more acceptable to the local industry. As is generally the case, it is likely that the best malting samples will be produced in the higher and moister areas with a longer growing season.

Proctor Barley

Proctor is a two-rowed barley from the cross Plumage Archer x Kenia bred in Britain where it has proved of high yield and grain quality. It combines the stiff straw of the Scandinavian parent with the quality of the Archer barleys.

Our experience with the variety in Kenya is still limited and its value is not yet clear because of unfortunate seasons during its trial period. Initial field-scale trials have shown that it can yield well, and it should provide a less coarse type of grain for malting purposes than the true Scandinavian varieties.

Boone Oats

Boone is a direct importation from the United States of America, derived from the cross Victoria x Richland.

It is of fair stiff straw, medium height, and mid-season maturity. It is primarily a grain type, although it also can produce a good bulk for hay or silage. It has yielded well over a wide range of conditions in Kenya, but seems unreliable for the lower altitudes on account of rust susceptibility. It is advised, therefore, that this oat be kept above 7,500 ft.

The grain is not acceptable for porridge on account of a characteristic taint in the product; but the variety should still be valuable for feed and hay or silage purposes.

R.L.1734 Oats

This is an oat of complex parentage developed in Canada.

It is of fairly tall, stiff straw, and mid-season to late maturity. It produces a large amount of bulk and is best considered a hay or silage type. It has grown well during multiplication in the Kitale area and should be suitable for a wide range of conditions in Kenya.

REVIEWS IN BRIEF

EQUIPMENT AND METHOD FOR FLUE-CURING TOBACCO. Interim Report No. 5, issued November, 1955, by the Tobacco Research Board of Rhodesia and Nyasaland, P.O. Box 1909, Salisbury, S. Rhodesia.

Detailed scale drawings of the curing equipment are given in this pamphlet and the flue-curing process is discussed from the point of view of the tobacco planter.

BEESWAX, by Frances G. Smith, Bee Division Pamphlet No. 1, Forest Department, Tanganyika. Published by the Government Printer, Dar es Salaam, Tanganyika, 1955, price Sh. 2.

This pamphlet replaces the previous Department of Agriculture Pamphlet No. 23 by W. V. Harris, which was published in 1940. The revised pamphlet concentrates on the production, treatment and marketing of beeswax.

A COURSE OF TWELVE LECTURES ON BEE-KEEPING, by Francis G. Smith, Bee Division Pamphlet No. 2, Forest Department, Tanganyika. Published by the Government Printer, Dar es Salaam, Tanganyika, 1955, price Sh. 1/50.

The lectures are presented in note form to be enlarged according to the knowledge of the lecturer and the interest and educational standard of the students.

YEARBOOK OF FISHERY STATISTICS, VOL. IV, PART I, 1954 SUPPLEMENT, AND PART 2. Food and Agriculture Organization, 1955.

Selected Catch and Landing Statistics, 1938, 1947–54, and estimated total international trade in fishery products of 110 countries 1950–53 including total imports and exports.

RAIN-MAKING—ITS PRESENT POSITION AND FUTURE POSSIBILITIES, by A. K. Roy. Council of Scientific and Industrial Research, New Delhi, India, 1955.

This bulletin of 31 pages summarizes what is definitely known on the subject of rain-making, how much of the information is definite, and what are the possible lines in which experiments on the problem can be undertaken in India. It is stated in the preface that: "There is no hope whatever of making clouds rain wherever and whenever one wants it. In certain areas and under favourable conditions of weather, it may be possible to do so, but how to define these conditions and determine the most suitable methods of stimulating the rain are matters for detailed and painstaking investigation".

AN EXPERIMENT ON STEM BORER CONTROL ON MAIZE

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(Received for publication on 13th February, 1956)

Stem borer attack on cereals is generally regarded as causing severe damage. The assessment of stem borer attack is discussed by Jepson (1954), who states that in experimental work using chemical control methods to demonstrate its pest status, difficulties are encountered in experimental design, since the smaller the plot (below half-acre in size) the greater the chance of cross-infection between plots. Duerden (1953) suggests that a universal insecticidal "blanket" treatment over the whole area would give a more effective control, and could be compared with an equal, untreated area. In the following account the use of both methods is reported. Control of stem borer was satisfactory, but no increases in yield were obtained. The possible reasons for this are discussed.

In maize (long-term variety Ulu 1) grown as a second rains crop (August–January) in 1953-4 on Namulonge, a potentially serious attack of stem borer was observed, comprising mainly *Busseola fusca* (Fuller) with a few *Sesamia* spp. An insecticidal trial was laid out utilising one strip of two acres and two strips of one acre each, all strips being 103½ ft. wide. The larger strip was divided up into four pairs of half-acre plots, with treatment and control arranged at random in each pair. The treatment consisted of 20 lb. D.D.T. dust/acre applied down the funnel of each plant using a rotary hand duster. Three applications were given at fortnightly intervals commencing when the seedlings were roughly nine inches high. On the two one-acre strips, one was given a "blanket" treatment using the same quantity of dust per acre and the same times of application, and the other was left as a control. Larval population counts were carried out on both experiments, taking 20 plants per plot in the randomized plot experiment and 100 plants per treatment in the "blanket" experiment and examining them for larvæ. Counts of larvæ were taken prior to each application. The number of larvæ was reduced progressively (*see* Table I).

At the last count the larval population and plants infected (those with stem borer holes in the stem) were reduced satisfactorily in the treated plots to 16 per cent and 30 per cent of the untreated plots respectively. The larval population on the "blanket" treatment was reduced similarly. (Table I.)

TABLE I.—INCIDENCE OF STEMBORER IN MAIZE

Treatment	No. larvæ/acre			% plants infected		
	1st sample	2nd sample	3rd sample	1	2	3
Control ..	5,600	4,900	6,300	24	21	28
Treatment	4,900	1,630	1,050	24	14	9
Control ..	4,270	4,480	4,900	33	17	36
Blanket treatment	5,600	3,080	280	30	24	2

Prior to harvest no obvious difference could be seen between the treatments. In particular, lodging, which is often a symptom of severe borer attack, was not more frequent in the control plots. A count was made along one row of each plot, taken at random, and the number of lodged plants counted and examined for infection by stem borer (Table II). There was no difference between "lodging" in infected and uninfected plants. The number of infected plants was shown to have increased since the last insecticide application, two months previously. This may have been due to cross-infection between plots as has already been mentioned.

TABLE II.—EFFECT OF TREATMENT ON THE NUMBER OF LODGED PLANTS AND COB WEIGHT

Treatment	No. plants infected			% plants infected	No. plants uninfected			Weight in lb. 25 cobs from	
	Standing	Lodged	% lodged		Standing	Lodged	% lodged	infected plants	uninfected plants
Control	59	15	20	31	117	48	29	17	20
Treatment	30	15	23	21	181	66	26	15	18

By the *chi squared* test differences in mean weight of cobs from infected and uninfected plants were not significant.

A cob sample was taken from each plot and weighed. From the mean cob weights (Table II) there was an apparent tendency for the cobs from uninfected plants to be heavier, but statistically the difference was insignificant. The final yields similarly showed no difference in both the plot experiment and the "blanket" experiment (Table III).

TABLE III.—MAIZE YIELDS FROM EACH TREATMENT

Plot No.	Yield lb./acre	Plot No.	Yield lb./acre	Difference	% Difference	Yields from "Blanket" Experiment	
						Treatment	Control
1 Control	1552	2 Treated	1669	−117	−7·5		
3 Treated	2517	4 Control	2678	−161	−6·3	lb./acre	
5 Treated	2228	6 Control	2571	+343	+15·3		
7 Control	2801	8 Treated	2552	+249	+9·8	2513	2555

There was no significant difference between yields. Standard error = ± 239.

From the data it appears that even this degree of damage to the stem by larval feeding, which was extensive, and often shown in more than one place along the stem, was not great enough to prevent full development of the cob. Evidently, however, the importance of a given amount of stem damage in affecting cropping will depend on environmental conditions, in particular water availability and fertility of the soil. Thus, a degree of stem damage that is unimportant with the good rainfall conditions and fertile soil of Namulonge might well be crippling under the hard conditions more characteristic of the grain growing areas of East Africa.

Acknowledgments

The writer wishes to thank Mr. K. S. McKinlay for his help in the commencement of the experiment and Mr. A. N. Prentice for the final yield figures.

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EAST AFRICA MILK RECORDS OF LEADING COWS—JUNE TO DECEMBER, 1955

By the East Africa Milk Recording Scheme, P.O. Box 478, Nakuru, Kenya

CLASS I (UNDER 2 YEARS OLD)

Name and Address of Owner	Name of Cow and Sire	Breed	Date of Birth	Lactation Records					
				No. of Lactation	Calving Dates	Milk Yield (lb.)	Days	B.F. %	B.F. (lb.)
1	2	3	4	5	6	7	8	9	10
Keringet Estates, Molo ..	Keringet Flora, *Waldron Doris' Martinus.*	Friesland P	17–7–52	1st	10–7–54	6,195·8	305	3·80	235·4
*Wolstaston Estate, Menengai	1 of 3 Kileges, *Oldamster Mylord.*	Friesland N.P.	9–1–53	1st	1–12–54	7,225·5	215	3·65	263·7
J. D. Heath, Endebess ..	Nerine of L'Ancresse (Imp.), *Throughly's Leader of Les Videclius*	Guernsey P	19–11–52	1st	9–11–54	5,286·0	295	4·91	259·5
D. E. Fielden, Nakuru ..	Kenya 8th No. 385, *Unknown.*	Jersey N.P.	10–6–52	1st	23–4–54	6,471·3	305	4·86	314·5

CLASS II (UNDER 2½ YEARS OLD)

Kivulini, Ltd., Molo	Kivulini Heather, 17th, *Inverurie Gold Digger.*	Ayrshire P	12–8–52	1st	12–10–54	6,894·1	305	4·20	289·5
A. J. Stewart, Njoro	Naivasha 6th No. 368, *Eglinton Mains Elegance.*	Ayrshire N.P.	5–6–52	1st	7–10–54	7,276·6	288	4·65	338·3
Keringet Estates, Molo ..	Keringet California, *Waldron Doris' Martinus.*	Friesland P	9–7–52	1st	13–8–54	7,377·7	305	3·67	270·7
*Wolstaston Estate, Menengai	36 of II Germani, *Unknown.*	Friesland N.P.	21–11–51	1st	8–4–54	7,959·1	305	3·71	295·2
Blundell Estate, Ltd., Nakuru	Maid Marion 5th of Cardington, *Ware Rose's Butterfat Governor.*	Guernsey P	12–4–52	1st	25–5–54	8,267·9	305	3·83	316·6
Rhodora Estates, Ltd., Nakuru	Nduos 8th D17, *Valentine of Fernhill Park.*	Guernsey N.P.	24–9–52	1st	11–1–55	8,448·9	305	4·80	405·5
Rodericklea, Ltd., Limuru ..	Pearcelands Lady Mint, *Crassvale Silvermine 4th Aim.*	Jersey P	6–5–52	1st	17–8–54	6,019·0	305	6·05	364·1
Maj. and Mrs. L. B. L. Hughes, South Kinangop.	Ursa M41, C.M., *Osirua Despot (Imp.).*	Jersey N.P.	21–1–52	1st	9–6–54	6,451·9	305	5·73	369·6

P.—Pedigree. N.P.—Non-Pedigree.

*Foot-and-Mouth Disease.

CLASS III (UNDER 3 YEARS OLD)

Name and Address of Owner	Name of Cow and Sire	Breed		Date of Birth	Lactation Records					
					No. of Lactation	Calving Dates	Milk Yield (lb.)	Days	B.F. %	B.F. (lb.)
1	2	3		4	5	6	7	8	9	10
Kivulini, Ltd., Molo	Kivulini Beauty 15th, *Eglinton Mains Blue Print.*	Ayrshire	P	21–10–51	1st	1–12–53	5,495·0	252	4·27	234·6
					2nd	16–10–54	8,134·5	298	5·20	422·9
A. J. Stewart, Njoro	Banjo 12th No. X365, *Eglinton Mains Elegance.*	Ayrshire	N.P.	6–3–52	1st	30–10–54	7,506·7	305	4·21	316·0
Gingalili, Ltd., Nakuru ..	Jantje A.9 (Imp.), *Reintje's Rutje's Eduard II.*	Friesland	P	27–7–51	1st	9–4–54	6,039·9	275	4·78	288·7
L. F. A. Green, Limuru ..	Njoro No. 28, *Garsden Nobleman.*	Friesland	N.P.	8–9–51	1st	4–8–54	7,446·0	294	3·90	290·3
F. R. Stephen, Nairobi ..	Rosarini Autumn Crocus, *Monarch of Ober.*	Guernsey	P	14–1–52	1st	6–10–54	9,282·7	305	3·61	335·1
P. E. L. Howard, Nakuru ..	Mosel I H.47, *Unknown.*	Guernsey	N.P.	8–5–52	1st	8–12–54	7,590·5	305	5·07	384·8
Osirua Jerseys, Limuru ..	Olivia's Dewdrop (Imp.), *Lady Olivia's Boy.*	Jersey	P	29–9–51	2nd	25–8–54	8,035·2	305	5·09	408·9
D. E. Fielden, Nakuru ..	Rubeni 12 No. 355, *Milpomenes Dreamer.*	Jersey	N.P.	10–12–51	2nd	31–7–54	5,732·6	305	5·64	323·3

CLASS IV (UNDER 4 YEARS OLD)

R. C. Long, Thomson's Falls	Inverurie Hazel 2nd (Imp.), *Coraville Gold Digger.*	Ayrshire	P	17–2–51	1st	18–6–53	5,532·2	305	4·36	241·2
					2nd	28–9–54	9,618·5	305	4·53	436·3
Lesirko, Ltd., Ol'Kalou ..	Lesirko No. 900, *Mtarakwa Senata.*	Ayrshire	N.P.	27–4–50	2nd	25–2–54	7,661·0	305	4·53	347·0
Barclay Estates, Ltd., Menengai	Menengai Goddess, *Karirana Jupiter.*	Friesland	P	30–6–50	1st	11–6–53	6,976·0	305	3·99	278·3
					2nd	25–6–54	9,388·0	305	4·93	462·8
W. K. Bastard, Nanyuki ..	Rusty No. 72, *Unknown.*	Friesland	N.P.	13–4–51	2nd	22–8–54	11,668·5	305	3·35	390·8
Rhodora Estates, Ltd., Nakuru	Rhodora Marlene, A.R., *Valentine of Fernhill Park.*	Guernsey	P	18–5–51	1st	23–9–53	6,466·4	305	5·75	371·8
					2nd	28–10–54	8,205·4	305	5·54	454·5
S. S. Bastard and Son, Sotik..	Bisiot 3rd No. 189, *Primrose's Countryman of Ray.*	Guernsey	N.P.	4–2–51	1st	10–5–53	6,949·0	305	4·15	288·3
					2nd	16–10–54	8,842·9	264	5·06	447·4
Dearlove and Jowitt, Ainabkoi	Southernwood Lucky Design, C.M., *Lynmouth Noreen's M.P. II C.M.*	Jersey	P	4–10–50	1st	11–8–52	3,676·7	246	6·53	239·9
					2nd	19–7–53	5,929·5	304	6·72	398·4
					3rd	30–7–54	6,588·6	299	6·21	409·1
ditto	Juniper No. 935, *Lynmouth Noreen's M.P. II C.M.*	Jersey	N.P.	7–5–51	1st	17–9–53	4,039·0	241	6·71	271·0
					2nd	3–9–54	5,209·5	305	6·56	341·7

P.—Pedigree. N.P.—Non-Pedigree.

*Foot-and-Mouth Disease.

CLASS V (UNDER 5 YEARS OLD)

Name and Address of Owner	Name of Cow and Sire	Breed	Date of Birth	Lactation Records					
				No. of Lactation	Calving Dates	Milk Yield (lb.)	Days	B.F. %	B.F. (lb.)
1	2	3	4	5	6	7	8	9	10
Kivulini, Ltd., Molo ..	Kivulini Beauty 14th, *Mtarakwa Neptune.*	Ayrshire P	25–9–50	1st	4–11–52	4,836·8	273	4·78	231·2
				2nd	7–10–53	5,940·0	286	4·80	285·1
				3rd	20–10–54	7,766·9	273	5·07	393·7
Lesirko, Ltd., Ol'Kalou ..	Lesirko No. 874, *Mtarakwa Senator.*	Ayrshire N.P.	2–9–49	1st	20–6–52	5,951·9	259	4·40	261·8
				2nd	12–6–53	6,939·0	259	3·28	227·6
				3rd	20–5–54	7,967·8	294	4·50	358·5
Gingalili, Ltd., Nakuru ..	Karirana Grilly, *Oldambtster Gysbrecht.*	Friesland P	21–8–49	1st	15–4–52	11,497·6	305	4·27	490·9
				2nd	22–2–54	13,250·8	305	4·55	602·9
ditto	Songoro, *Unknown.*	Friesland N.P.	18–10–49	1st	23–1–53	6,893·9	305	3·46	238·4
				2nd	12–4–54	9,959·0	305	4·28	426·2
Coull Farm, Nakuru ..	Coull Sunray Ober, *Monarch of Ober.*	Guernsey P	28–8–49	2nd	28–10–52	6,185·9	259	4·10	253·6
				3rd	1–8–54	8,341·0	305	4·32	360·3
Karamiat Farm, Eldoret ..	Kenya No. 18, *Unknown.*	Guernsey N.P.	Unknown	1st	31–7–54	6,858·5	305	5·88	403·2
*Rodericklea, Ltd., Limuru	Mornmoot Fancy Starbright 55th (Imp.), *Selsey Champions King.*	Jersey P	10–10–49	1st	28–7–52	6,677·7	245	4·97	331·3
				2nd	24–8–53	7,450·1	294	4·85	361·3
				3rd	29–9–54	7,883·6	305	4·96	391·0
D. E. Fielden, Nakuru ..	Lair 4 No. 258 C.M., *Osirua Jupiter.*	Jersey N.P.	14–10–49	1st	17–2–53	5,669·6	305	6·85	388·3
				2nd	14–4–54	7,169·3	305	6·80	487·5

CLASS VI (MATURE)

A. J. Stewart, Njoro	Mtarakwa Priscilla, *Benmore Yeoman.*	Ayrshire P	20–1–47	4th	30–10–52	9,454·0	288	3·70	349·8
				5th	15–12–53	9,519·9	276	4·33	412·2
				6th	10–12–54	10,937·0	275	4·33	473·5
Lesirko, Ltd., Ol'Kalou ..	Lesirko No. 692, *Kinsman of Kivulini.*	Ayrshire N.P.	10–9–44	2nd	12–12–50	10,491·3	364	3·82	400·7
				3rd	24–10–52	9,525·4	273	3·94	375·3
				4th	18–6–54	11,402·1	305	4·04	460·6
Gingalili, Ltd., Nakuru ..	Glenstuart N.V. Ailsa A.R. (Imp.), *Glenstuart Netherland Victory.*	Friesland P	12–10–48	2nd	4–2–53	17,913·8	299	3·96	709·3
				3rd	15–1–54	14,952·0	266	3·77	563·6
				4th	5–1–55	21,690·1	305	3·89	843·7
ditto	Georgie, *Unknown.*	Friesland N.P.	12–3–49	1st	25–3–52	8,087·2	305	3·33	269·3
				2nd	1–6–54	14,865·7	305	3·18	472·7
Ol Bonata, Ltd., Nakuru ..	Cherkley Regent's Isobella A.R. (Imp.), *Tackley Regent 9th.*	Guernsey P	17–3–46	2nd	26–6–52	8,323·6	273	4·26	354·5
				3rd	27–7–53	9,900·2	305	4·24	419·7
				4th	2–9–54	11,479·8	305	4·43	508·5
S. S. Bastard and Son, Sotik..	Mororoch No. 136, *Unknown.*	Guernsey N.P.	15–9–48	2nd	25–4–52	9,690·6	265	4·00	387·6
				3rd	5–3–53	9,704·7	305	4·04	392·0
				4th	25–5–54	13,180·9	303	4·40	579·9
Dearlove and Jowitt, Ainabkoi	Southernwood Star, O.M., *Lynmouth Noreen's M.P. II.*	Jersey P	19–7–47	3rd	24–1–52	6,809·0	246	5·88	400·3
				4th	29–12–52	7,254·0	305	6·33	459·1
				5th	16–6–54	6,879·0	305	6·49	446·4
Mrs. M. Repton, Gilgil ..	Mania No. 810 *Unknown.*	Jersey N.P.	Unknown	1st	12–2–53	7,690·0	305	6·35	488·3
				2nd	24–6–54	7,747·6	305	5·76	446·4

P.—Pedigree. N.P.—Non-Pedigree.
*Foot-and-Mouth Disease.

CRUDE FIBRE: ITS DETERMINATION AND ITS PLACE IN THE ANALYSIS OF ANIMAL FEEDING-STUFFS

By H. W. Dougall, Grassland Research Station, Department of Agriculture, Kenya

(Received for publication on 29th January, 1956)

For over 100 years, agricultural chemists have sought to estimate, with greater accuracy, the indigestible fractions of animal feeding-stuffs. In the middle of the nineteenth century it was thought that some insight into the digestibility of a foodstuff as a whole might be gained from a knowledge of its content of water-insoluble residues. Such residues were obtained by exhausting the material alternately with cold and boiling water to remove readily soluble matter, next with alcohol to remove any colouring matter, and finally with ether until the fibre became white in colour. This material was then dried and weighed as "cellular fibre". It contained insoluble protein compounds and inorganic salts which, fortunately, could be estimated respectively as "nitrogen" and "ash" and a value for "pure cellular fibre" could thus be obtained by difference. Voelcker [1] did not believe that the cellular fibre, of root crops at least, is completely indigestible, but held the view that their soft young fibres are converted readily in the stomachs of animals into gums and sugar, and "applied in the system to feed the respiration, or for the formation of fat".

By 1861, Voelcker [2] had classified the components of animal feeding-stuffs as follows: (i) water; (ii) nitrogenized substances; (iii) non-nitrogenized substances and (iv) mineral substances or ash. In his group of non-nitrogenized substances he included: (*a*) oil, fatty and waxy matters with more or less "chlorophyle"; (*b*) sugar; (*c*) gum and mucilage; (*d*) extractive matters and occasionally bitter principles; (*e*) cellulose, and (*f*) woody fibre. This recognition of cellulose and woody fibre as separate plant constituents did not cause him to abandon his original determination of cellular fibre; he took the procedure much further and began to estimate the extent to which this impure residue resisted attack by dilute (1 per cent) caustic potash and by dilute sulphuric acid. Voelcker reasoned that different alkaline and acid secretions within the animal exercise at least similar, and probably even more energetic, effects upon the cellular fibre, and that consequently the result following alkaline and acid digestion affords better insight into the palatability of plant materials than mere exhaustion with water. He renamed the material resisting water-exhaustion "crude woody fibre" and called the material resisting alkaline and acid digestion "cellular and woody fibre". It was considered by him to be a mixfure of cellulose, the substance composing the cell-walls of plants and of woody substances or "incrusting matter" which are deposited around the original cell walls. The woody substances were believed to constitute the true wood or woody fibre of plants. It is clear that Voelcker recognized cellulose and woody fibre as separate entities, but he knew of no chemical methods for determining the two independently. He concluded that his determination of the mixture of "cellular and woody fibre" could not be expected, at the best, to give more than a very rough idea of the true character of the insoluble matter and of its digestibility. Indeed, he doubted that even well-conducted feeding experiments could elicit, with certainty, results indicative of the extent to which the woody fibre of plants is digested by animals.

At the time Voelcker was giving so much attention to the measurement of the indigestible fraction of animal feeding-stuffs in England, Henneberg and Stohman at Weende, near Gottingen, were engaged in precisely the same problem and, so it would appear, they were thinking along very much the same lines. Their work resulted in the publication, in 1860, of a method [3] for the determination of fibre insoluble in dilute (1.25 per cent) sulphuric acid and in dilute (1.25 per cent) potash—the so-called "wood fibre". This material has been guardedly defined as "the sum of all those organic components of the plant cell membrane and supporting structures, which in chemical analysis of plant foodstuffs remain, after removal of crude protein, crude fat, and nitrogen-free extractives". (Mangold, [4]). The method of Henneberg and Stohman has survived for nearly a century albeit "honoured

more in the breach than in the following" [5], and it is recorded below:—

> "About 3 g. of dried feeding-stuff or fæces (oil-cake after extraction with ether) is boiled for half an hour with 50 ml. 5 per cent sulphuric acid and 150 ml. water, with replacement of the water evaporated, in a porcelain dish and then left to settle; the fluid is removed with a small glass syphon, the residue is boiled twice with water (200 ml. on each occasion) and the fluid syphoned off each time is added to the first extract. The residue is then treated in the same way, first with a mixture of 50 ml. 5 per cent potash and 150 ml. water, then with water, and is finally transferred to a weighed filter. The potash solution is removed as completely as possible by syphon and the deposit is added to the contents of the filter, which are washed until the alkaline reaction disappears. The deposit from the acid solution is also added and then the whole is thoroughly washed in succession with water, alcohol and ether, dried, weighed and ashed for the estimation of ash. The ash-free residue is taken as crude fibre."

This method for the determination of fibre is known in agricultural literature as the "Weende" procedure to perpetuate the name of the research station from which it originated. It is interesting to note that whereas Voelcker treated his materials with alkali first (in order to break down albuminous compounds), Henneberg and Stohman reversed this procedure and employed acid first. Henneberg [6] again described the method in 1864.

Henneberg and Stohman showed how results in the crude fibre estimation may be affected by the fineness of the sub-division of the original material, and they felt obliged to assume that where a qualitative difference on this account does occur, it will almost certainly be accompanied by a quantitative difference. "Therefore," they observed, "what we according to custom have called wood fibre, is probably not the same when it is derived from the same feed prepared by different mechanical means. For that reason alone, it is desirable that the residues after acid and alkaline treatment should have a less definite designation than wood fibre; this is all the more true if it can be shown that with exactly the same procedure, the residues from different substances are of widely different composition (e.g. those from clover hay quite different from wheat straw, or from fæces and clover hay) and are significantly different from the pure wood fibre of the chemist ($C_{12}H_{10}O_{10}$). We are impelled to propose the name "crude fibre" for this doubtful residue, and will continue to use it until a procedure has been found to estimate the true wood fibre content of feeding-stuffs".

It is perfectly clear from the foregoing that Henneberg and Stohman were well aware that the fraction of animal foodstuffs which resists acid and alkaline digestion is an impure residue, and that its composition will vary almost certainly with the nature, stage of growth and state of sub-division of the original material. Unfortunately, like Voelcker, they knew of no chemical methods for fractionating this residue.

It is not perfectly clear when the "Weende" procedure came to be used in Great Britain, though Dr. Charles Crowther [7] considers that "in principle" at any rate, it has been universally followed since Henneberg and Stohman embodied it in their scheme for the analysis of feeding-stuffs. An earlier version of the method is to be found in a book on agricultural analysis by Addyman [8] who, in 1893, described the determination of woody fibre in oil-cakes and in grass and hay. This is of historical interest for two reasons: firstly because for oil-cake crude fibre, 50 ml. of 5 per cent acid and alkali are used alternately with the addition of 75 ml. water, whereas for grass and hay crude fibre, double the quantity of liquid is used; and secondly because Addyman filtered his residues after each of the digestions on linen. It is said [7] that the chemists of those days exercised a freedom to ignore the "letter of the law" and this may well account for Addyman departing from "conventional" procedure. There can be no doubt that T. B. Wood [9] gave publicity to the "Weende" procedure when he reported the "Methods for the Analysis of Artificial Manures and Feeding-stuffs" adopted at the General Meeting of the 5th International Congress of Applied Chemistry in Berlin (3rd June, 1903). He recorded that the sample of feeding-stuff is ground to pass, if possible, through a 1 mm. sieve and that crude fibre is estimated as follows: "according to Weende's method, 3 g. of substance from which the fat (if present) has been extracted, are boiled with 200 ml. of 1.25 per cent sulphuric acid and 200 ml. of 1.25 per cent potassium hydrate solution. Each boiling must last for half an hour, water being added to replace the

evaporated portion. Each treatment with acid and alkali must be followed by a boiling with water. The residue to be washed with hot alcohol, then with ether, and dried to constant weight. The ash of the residue must be subtracted". Wood commented that it would be for the general good if all analysts could agree to determine fibre in the same way, for the result must vary with details of method.

It would appear that the chemists of the day were disinclined to agree to a standard procedure, and when the Fertilizers and Feeding-stuffs Regulations (Methods of Analysis) appeared in 1908, a method for determining crude fibre was not included. During the same year the Board of Agriculture explained that it would not be practicable to prescribe methods for other analyses which might be required under the Act. Nevertheless, though the Weende procedure did not receive legal recognition at this time, its purpose did not escape the attention of the Board which, in its leaflet No. 74 [10], defined crude fibre as "that portion of the foodstuff which remains undissolved after boiling in weak acid and alkali. It represents those ingredients which are of a more or less woody character, and it is essentially an admixture of cellulose with highly indigestible substances (lignin, cutin). Its value for feeding purposes varies widely according to its mechanical character and the class of stock to which it is fed".

By 1924, Wood [11] had described the method for estimating crude fibre, as taught by him to degree students at Cambridge, certainly in 1919 and, according to Woodman [12], in all probability many years earlier. Wood's method is based on the Weende procedure but departs from it: (i) in the use of sodium hydroxide in place of potassium hydroxide; (ii) in the use of linen for filtration after acid and alkaline digestion; and (iii) in washing residues with hot water instead of boiling them in it. Such modifications no doubt were introduced as time-saving devices to replace the somewhat archaic and tedious procedure of the Weende workers, and the sodium is a less expensive reagent than potassium. By 1928, an "official" method for determining crude fibre, based on the "Weende" procedure, was incorporated in the Fertilizers and Feeding-stuffs Regulations. The publication of this long-awaited official method came as one of the results of co-operative experimental work amongst certain agricultural chemists, under the impetus of the Chemistry Committee of the Agricultural Education Association.

It was anticipated, not unnaturally, that this new and modernized version of the Weende procedure would be accepted generally and followed strictly, but it is at least doubtful if this is so at the present time. There is a great diversity of practice to-day which seems to come mainly from a desire of agricultural chemists to seek improvement in analytical procedure where it is most necessary. Thus Addyman, as already noted, modified the Weende technique for filtration because he obviously found it cumbersome. Steigler [13] criticized it also on the grounds that it was a difficult technique, and Wood adopted Addyman's procedure and filtered through linen. In the Fertilizers and Feeding-stuffs Regulations, filtration after acid digestion is carried out on filter paper, using a funnel specially prepared for the purpose; but after alkaline digestion, through ordinary filter paper in the usual way. Hartley [14] follows this procedure, but he has introduced a two-piece filter funnel in order to increase the efficiency and accuracy of the operation. Knowles and Watkin [15] continue to use linen, and this technique is also followed in America, where its use is recommended in the "official" procedure [16] for that country. Some chemists seek to improve on the technique of digestion by attaching an air or a water-condenser to the conical digestion flask in order that its volume remains constant throughout the digestion process, and others, like Wilkes [17], seek to reduce frothing during the alkaline digestion by introducing organic defoaming agents such as capryl or amyl alcohol. For the same reason Fill and Stock [18] used a reflux apparatus or "cold finger" so that froth is automatically dispersed during digestion. More recently, Barnett [19] has described his method for estimating crude fibre. He uses a 4 ft.-long air condenser to maintain volume, and a thin side-tube to overcome frothing; he filters through linen after the acid digestion and through filter paper after the alkaline. His residue is ignited at a specific temperature (600°C) for a specific time (20 min.), and it is not simply incinerated at "dull red heat".

Some chemists, including Hannerz [20], have studied the way in which increasing the time of digestion affects the crude fibre determination, and others, e.g. Lepper [21], have studied the effects of varying the concentrations of the reagents. Work of a similar nature

is reported by Hallsworth [22] who proposed the possibility of using a single reagent only (5 or 7.5 per cent sulphuric acid for one hour) for the estimation of crude fibre, and by Hall *et al.* [23] who include also a study of the effects of ebullition on this determination.* On the whole, there seems very little reason to suppose that the position concerning the crude fibre determination is any better in Great Britain to-day than it was in America, for example, in 1947. From that country Hunter [5] reported that in 71 replies received in answer to a questionnaire sent to official and industrial laboratories in the U.S.A., almost 70 variations from official procedure (A.O.A.C., Methods of Analysis, 1945) were recorded. Hunter endorses the view expressed by T. B. Wood almost 40 years before and states: "this empirical determination must be closely followed if concordant results are to be obtained".

While some chemists are engaged in seeking to improve the method for determining crude fibre, others are questioning the value of the estimation in the chemistry of animal nutrition. In the early days of feeding-stuffs analysis, chemists anticipated that the crude fibre determination would give a rough measure of the indigestible matters of food and, indeed, the fraction so determined was frequently designated "indigestible fibre". Subsequent research is showing that the fraction is far from wholly indigestible, although it does give "a rough idea of the hard, tough, difficulty-soluble material in the foodstuff" [24]. Norman [25] criticizes the determination on the grounds that the fraction obtained bears no definite relationship to the structural constituents of the original material; that the acid and alkaline digestion respectively cause cellulose to be partially attacked and lignin to be extensively removed; and that the plant materials rich in lignin do not necessarily give a lignin-rich crude fibre. He considers that, since lignin exercises a direct effect on the digestibility of foodstuffs, any empirical method should be designed to include all the lignin and alkaline treatment avoided. Woodman and Evans [26] find that in such materials as grasses and their products the crude fibre may be as well digested as the N-free extractives, and similar results are reported by French [27] and Rogerson [28] in East Africa. Crampton and Maynard [29] record that the crude fibre in forages may be as well digested as the crude protein and they question the value of the Weende determination on the grounds that the fraction so measured is not wholly digestible. They propose that the present division of the carbohydrate fraction of feeding-stuffs into N-free extractives and crude fibre should be replaced by the determination of : (i) "lignin", a practically non-digested portion; (ii) "other carbohydrates", a highly digestible fraction; and (iii) "cellulose", which is both chemically and biologically a recognizable unit. This proposal is supported by Armstrong *et al.* [30] who also consider that lignin should be determined and that the remaining carbohydrate fraction should be separated into its chemical entities.

On the other hand, Walker and Hepburn [31] call attention to the considerable evidence obtained in different geographical regions that, with some exceptions, there is a high negative correlation between the crude fibre content in the organic matter of roughages and the digestibility of the organic matter. Their own work shows that a close relationship exists between the gross digestible energy contents of hays and their structural components, as represented by crude fibre, lignin and cellulose; they find that no improvement in the accuracy of predicting the "digestibility of energy" is obtained by determining the lignin and the cellulose as against the crude fibre by the A.O.A.C. method.

The future of the crude fibre determination in animal feeding experiments of a fundamental character may not be secure. It is unlikely, however, that this determination, which has survived for almost a century, will be abandoned until it is unanimously agreed that a more accurate prediction of the nutritive value of a feeding-stuff can only be made when its composition is based on more precise chemical constituents.

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* *See also* Todd, J. R., *Nature* (1951), *168*, 76, and Dougall, H. W., *Nature* (1955), *175*, 952, who have studied the effect on this determination of lowered boiling points at high elevations.

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SOME PESTS OF BLACK WATTLE IN KENYA

WITH A LIST OF OTHER INSECTS INHABITING THE PLANTATIONS

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The black wattle tree (*Acacia mollissima,* Willd.) has been grown in Kenya as far back as 1903, when it was employed by the Uganda Railway for the production of fuel. In 1910 the first overseas shipment of bark was made and since that date, there has been a steady development of the industry. Its early growth was centred chiefly in the African areas of the Central Province along the slopes of the Aberdares and Mount Kenya. Here, the growing conditions were so favourable that a satisfactory tree could be grown under the most primitive of silvicultural systems and yet produce a satisfactory return. This, coupled with the fact that the plantations were small and scattered over a vast area, together with the general lethargy towards improvement of farming methods so often exhibited in the past by the African, has led to a neglect of the cultural problems affecting the industry.

The period following the end of the second World War has seen a rapid increase in the acreage planted to wattle within the European areas, particularly on the Uasin Gishu Plateau, where it is estimated that some 60,000 acres of wattle trees are now established. Many of the plantations are in compact units and range in altitude from 6,000 to 9,000 ft. above sea level. The area also shows appreciable variations in soil type and rainfall. These conditions provide excellent opportunities for study of the wide range of problems that are bound to arise with any large agricultural or forestry undertaking. Thus, in October 1950, the East African Tanning Extract Company Limited opened a research branch within their organization to cater for the requirements of the industry in this sphere.

Many of the problems being tackled, particularly those with a bearing on the silviculture of the tree, will take many years to resolve, since the crop is grown on an eight-to-ten-year rotation.

There are, however, other aspects which lend themselves, in some cases of sheer necessity, to the production of more rapid results. Into this latter category falls the study of the entomology of the wattle plantations, with of course, emphasis on those species which are likely to be harmful.

It is an inevitable result that when a uniform crop is established over large areas it brings with it, or develops *in situ,* its own range of pests and diseases. Common examples of this are the boll-worm in cotton or the rusts in wheat and maize. To this rule, the wattle tree is no exception, although the problems in Kenya have been neither disastrous nor insurmountable. The purpose of the present report is to provide an account of those pests encountered in the industry over the past few years, the methods of control where known, and a list of the insects so far collected from the plantations, whether of an injurious, innocuous or beneficial character.

THE NEMATOCERUS WEEVIL

(*Nematocerus perditor,* Mshl.)

The activities of this pest since it was first recorded in wattle in 1949, have lately reached a proportion which places it in the forefront of pests affecting the wattle industry of Kenya. In the following pages are detailed the known facts of its behaviour and the methods of control that have been developed.

Life Cycle and History

Little is known of the life cycle of the creature, but it is possible that the eggs are laid and complete metamorphosis takes place in the soil. Walker [1] records that larvæ have been found in the soil at Kitale. Adults have been observed by the writers emerging from the soil. Mating occurs almost immediately after the adult weevil emerges.

The adult weevil is bronze-black in colour. approximately 6 mm. long by 2½ mm. wide over the broadest part of the abdomen.

The period of infestation is closely related to the seasonal rainfall. It commences shortly after the onset of the rains, generally late April, and tails off towards the end of August. No build-up period over one season has been observed to occur; weevils suddenly appear in large numbers in areas which have previously been free. The annual foci and occurrence of infestations have generally been scattered and spasmodic. This suggests an endemic and

universal distribution of the creature throughout wattle-growing areas. The Agricultural Department [2] records *Nematocerus* spp. in their list of important pests of maize, wattle and wheat. Infestations have been reported throughout many areas of Kenya and its status as a pest is designated as "sometimes severe".

The first recorded outbreaks in wattle were in 1949 on the estate of Eldoret Wattle Estates Ltd., nine miles North of Eldoret, and on the Ngeria Estate of the Plateau Wattle Company, Ltd., 18 miles from Eldoret. The former outbreak was serious and some 300 acres were attacked, 150 acres of newly established wattle being completely destroyed. The latter outbreak caused only slight damage in one block of new sowing. It was during this period that the weevil was first listed as a pest of wattle and was tentatively identified and referred to as belonging to the genus Systates. In 1953 it was identified as *Nematocerus perditor*, Mshl., by the British Museum.

The following year, a second severe outbreak occurred on the Eldoret Wattle Estates Ltd's. plantation, and further outbreaks were recorded on the Nandi Border Estates of the Plateau Wattle Company Ltd.

In 1951, a small outbreak was reported from Eldoret Wattle Estates Ltd. in young re-establishment but was successfully controlled. During 1952 no serious infestations were reported, although isolated weevils were observed in all the principal wattle-growing areas of the Uasin Gishu.

A moderate infestation was reported in 1953 on the Plateau Wattle Company's Lolgarini Estate at Kipkabus in a five-acre block of one-year-old re-established trees which had been severely retarded in growth by heavy grass competition. Two further, but milder, outbreaks occurred in the same area in July and August.

Later in the year it was found that some 300 acres had been severely attacked on the Plateau Wattle Company's Outspan Estate, seven miles from Eldoret, but the infestation had escaped notice until too late and the majority of the young seedlings were destroyed.

The outbreaks during 1954 are the worst on record. The first attack was once again recorded from the Eldoret Wattle Estates Ltd. on 29th April, where it occurred in exceptionally good blocks of trees re-established at the beginning of the rains. The infestation rate, calculated from counts taken over a large number of random samples of one sq. ft., numbered 400,000 weevils per acre.

A second serious outbreak followed shortly on Outspan Estate where the infestation rate was calculated at over 200,000 per acre. From the beginning of May until the end of July reports of serious infestations came in from Turbo, Soy, Nandi Border, Kipkabus and Ainabkoi districts and active control measures were taken throughout.

During 1955 no significant numbers of the weevil were reported.

From the above it may be seen that the severity of annual outbreaks varies considerably, but that the general tendency has been for them to increase in intensity and distribution. An attempt has been made to correlate these outbreaks with seasonal rainfall, but little is yet apparent, apart from the writer's observations that mild seasons with light and well-distributed rain favours the development of the insect into pest proportions.

Nature of Attack and Damage

Earliest reports of infestations always suggested that they took the form of migrations from adjacent grassland into the blocks of germinating wattle seedlings. From the point of entry into the block they advance in a manner similar to the army worm, laying waste all young wattle growth encountered.

Subsequently, not only have these migrations been observed from the neighbouring veld, but also from blocks of older trees adjacent to the susceptible areas, where presumably, mild infestations have occurred in a previous season and the area subsequently has become a breeding ground. The wattle tree is most susceptible to attack as the germinating seedling budgeons from the soil and in the ensuing cotyledon stage. In these cases the weevil destroys the seedling by chewing through the tender young stem at ground level. The severed hypocotyl and root system are incapable of recovery and, although remaining alive in the soil for a period, ultimately die. The tree remains in this susceptible state for a month to six weeks while the primary leaves are forming and rapid growth commences. Over this period whole stands may be wiped out in as little as 24 hours. As the tree grows, the stem becomes less palatable and the attention of the weevil is directed to the leaf and growing point.

Attack in this later stage may, if unnoticed, result in complete destruction. However, this is not achieved so rapidly, and provided the attack is observed in time, control measures may be carried out with better chances of success. Thus as the young seedlings grow and their tissues become toughened, the likelihood of serious damage becomes successively less. On reaching a height of about six inches, serious defoliation may still be caused, but the chances of recovery are good.

The advance of the pest through wattle land, clear of undergrowth, is rapid and a 100 per cent loss may occur if unchecked. In land containing couch grass and weed growth, this advance may not be so fast, but lingers for a longer period, especially when control measures are carried out, as much alternative food material is available. Since the initial stand of trees in these areas is seldom as good as in clean land, losses may ultimately be more serious than in the former state, and far greater difficulty will be experienced in regeneration since grass competition rapidly becomes a serious factor.

Control Measures

Following the first outbreaks in wattle in 1949, an Entomologist of the Department of Agriculture investigated the problem [3]. A number of trials were carried out from which it was found that low concentrations of DDT and BHC dusts were ineffective and that spraying with an Agrocide wettable powder was considered prohibitively expensive. Following cage tests at the Agricultural Department's Experimental Farm at Kitale, the following bait was found successful and recommended—

3 lb. chopped green maize leaves,

1 oz. Agrocide 7 powder (2.6 per cent gamma BHC).

The bait was spread along the rows of young seedlings and proved effective.

In the attack which occurred the following year, 1950, on the Eldoret Wattle Estates, no bulk of green maize was available, but it was found possible to use couch grass (*Digitaria abyssinica*) as a less attractive substitute. (In the opinion of the writers, any such fresh green material may be substituted with a reasonable degree of success.) It was also observed that flavouring the bait with the addition of ½ fl. oz. molasses to 3 lb. bait improved its palatability.

In 1951 the small outbreak which occurred on Eldoret Wattle Estates Ltd. was successfully controlled using chopped prickly pear leaves at the rate of 3 lb. to 1 oz. BHC (2.6 per cent gamma).

The drawbacks to baiting with fresh vegetable matter are firstly, the necessity of having an adequate and suitable supply on hand at the right time; secondly, the amount of labour and time involved in the collection and chopping of the material, and thirdly, the bait has to be renewed every few days, as it is only effective when relatively fresh. As may be expected, the prickly pear retains its freshness for the longest period, but the growing of large quantities of this slow and unfriendly plant would be a formidable undertaking.

With these points in mind, the writers reverted once more to the trial of dusts and sprays, and in 1953 conducted a series of preliminary trials on the outbreaks at Kipkabus.

The first was carried out in a poor and very grassy stand of one-year-old trees which were suffering heavy defoliation. A dust containing 0.65 per cent gamma BHC was applied to the trees in a swathe 18 in. to 2 ft. wide at the rate of 15 lb. per acre.

The manner of application was by half filling a small hessian bag with the dust and shaking it over the trees by hand. The beetle is successfully controlled at this rate. The cost per acre was estimated to be Sh. 16.

A subsequent outbreak in an adjacent area where the infestation rate was calculated to be 6,000 weevils per acre and an equal quantity of *Megalognatha meruensis* Wse. afforded an opportunity for further trials to be carried out. The following insecticides were applied to 1-20th acre plots with a knapsack sprayer—

	Rate per acre Per 60 gal. water
Dieldrin	
(*a*) 28.7 per cent Emulsion	1 pint
(*b*) 25 per cent Wettable powder ..	5 oz.
(*c*) 28.7 per cent Emulsion	3 pints
Toxaphene	
(*d*) 50 per cent Paste	30 oz.
(*e*) 20 per cent Wettable powder ..	50 oz.
(*f*) 15 per cent in Kerosene	1 pint
(*g*) 50 per cent Paste	60 oz.
(*h*) Control.	

No immediate knock-down was observed with the *Nematocerus* or *Megalognatha*, which were active and feeding two to five hours after spraying.

Specimens collected from each plot immediately after spraying were examied 24 hours later. The *Megalognatha* were found to be dead or moribund from treatments (*a*), (*b*) and (*c*). *Nematocerus* were unaffected by any of the treatments.

A third test was carried out in a ten-acre block of four-month-old wattle. The stand was sparse and transplanting had been resorted to. The infestation was estimated at only 600 per acre. The following insecticides were each applied to two replicates of 1/10th acre—

Lindane	*Rate per acre*
(*a*) 2 per cent Dust	.. 15 lb.
Dieldrin	*Per 30 gal. water*
(*b*) 25 per cent Wettable powder ..	3 lb.
(*c*) 28.7 per cent Emulsion ..	.. 10 fl. oz.
(*d*) Control.	Untreated.

Lindane had an immediate knock-down, killing the weevil within 15 to 30 minutes. All other treatments showed no immediate effect and counts made some days later showed equal mortality in the untreated plots.

The results were generally inconclusive, but indicate that the weevil is a relatively insensible creature to sprays of low concentration, but is more susceptible to insecticide carried in dusts, from which relatively rapid results may be achieved.

In 1954, as reported earlier, the first outbreaks were recorded in excellent stands of re-established wattle on the Eldoret Wattle Estates Ltd., where counts of up to 400,000 weevils per acre were made. Immediate baiting, using the prickly pear, BHC mixture, was commenced and, although several rebaitings were carried out with some effect, it proved to be incapable of adequately controlling the infestation. In the writers' opinion, it would only have proved effective if applied at the rate of 300–500 lb. per acre.

Messrs. Eldoret Wattle Estates Ltd. then commenced dusting with Agrocide 7 dust (2.6 per cent gamma BHC) at the rate of 20 lb. per acre. The following day, up to 300 dead weevils were counted per square foot on the wattle lines where dust had been applied. Unfortunately, rain rapidly dispersed the dust and the effects were therefore limited. Using a dust of this strength, although effective, is nevertheless very expensive since it alone costs Sh. 24 per acre when applied at the rate described.

As recorded elsewhere, outbreaks were observed on the Plateau Wattle Company's Outspan Estate shortly afterwards and baiting was commenced using the prickly pear bait.

Here again it was soon evident that the method was impracticable for infestation of the scale now being experienced.

It was therefore resolved to try a bait using maize meal according to the following formula—

Maize meal, 3 lb.;

Agrocide 7 (2.6 per cent gamma BHC) 1 oz.;

Water, ½ pint.

The mixture was spread in one-foot lines along the rows of germinating wattle at the approximate rate of 15 lb. per acre. It proved an immediate success.

It will be recalled that an infestation rate of 200,000 weevils per acre had been calculated for this outbreak. Three days after the baiting with maize meal the mortality averaged 125,000 per acre, or 62.5 per cent kill.

The bait was dispersed by rain and a second baiting applied six to seven days later. Since dead weevils remained from the first baiting, it was not possible to accurately assess the effect of the second baiting, but it was estimated to account for between 60,000 and 80,000 per acre.

A count of living weevils at this stage was found to be not more than 1,000 per acre. Natural mortality was not determined and it is therefore impossible to calculate the exact kill. In cage tests it is shown however that on the whole, natural mortality is low over a short period. It may, therefore, be assumed beyond all reasonable doubt that the bait was highly effective, and for practical purposes total kills (including natural mortality) can exceed 99 per cent.

In May a field trial was carried out on Outspan Estate using the following baits at 10 lb. per acre.

		Total Mortality after 24 hours
1. 10 per cent D.D.T. Dust	1 oz.	1,742 per acre.
Maize meal	3 lb.	
Water	½ pint	
2. 10 per cent D.D.T. Dust	1 oz.	24,394 per acre.
Maize meal	3 lb.	
Water	½ pint	
Molasses	1 oz.	
3. 2·6 per cent gamma BHC	1 oz.	47,916 per acre.
Maize meal	3 lb.	
Water	½ pint	
4. 2·6 per cent gamma BHC	1 oz.	97,574 per acre.
Maize meal	3 lb.	
Water	½ pint	
Molasses	1 oz.	

This test indicated clearly the increased value obtained from the bait by the addition of but a very small quantity of molasses which served to enhance its attraction. The superiority of the 2.6 per cent gamma BHC bait over that employing 10 per cent DDT was also clearly demonstrated and it was recommended for general use. The chairman of the Wattle Growers' Committee of the Kenya National Farmers' Union was informed and all individual growers circularized to that effect.

As may be expected, the effectiveness of baiting was found to vary considerably according to conditions. Heavy rain immediately after would cause dispersion and render it relatively ineffective. Under very damp conditions it would rapidly become mouldy and unpalatable. In a clean wattle land it was particularly effective as there was little alternative food material. On the other hand, it did not prove so successful in grassy or weedy plantations where it is assumed that a great deal of alternative food material was available and the weevil tended to linger on for considerable periods in and amongst the weed growth, making but occasional sorties into the wattle lines or bait. In many areas it was therefore necessary to continue baiting over a number of weeks.

In June and July a number of trials were carried out to obtain data on Toxaphene and Chlordane insecticides as baits. The results were generally inconclusive, but served to indicate that BHC was still the most effective.

Dusting with a 0.65 per cent gamma BHC dust was tried but without success, chiefly due to unsatisfactory atmospheric conditions which made it impossible to lay the dust where it was wanted.

In late July, a spraying test was carried out in conjunction with Messrs. Fisons Pest Control (E.A.) Ltd., and the following insecticides applied—

	Per acre
25 per cent DDT Emulsion	2 and 4 pints
Chlordane Technical	2.5 pints
3.25 per cent gamma BHC ..	2.5 and 5 pints

The last two sprays scorched the young wattle seedlings. The 25 per cent DDT emulsion appeared promising but at this period, infestation rates were so low the results were once more inconclusive.

During late August and September infestation rates were too low to permit any further field work to be carried out. A number of cage tests were commenced to determine whether the current bait could be improved upon and made cheaper. Maize cobs were ground in a hammer mill to the same consistency as maize meal and the following baits prepared—

Bait	Cob Meal	Agrocide 7 2·60 % gamma BHC	Molasses	Water
C.M. 1	3 lb.	1 oz.	1 oz.	1 pint
C.M. 2	3 lb.	2 oz.	2 oz.	1 pint

These were applied to young wattle seedlings in cages at the rate of 15 lb. per acre.

Two further cages were employed, one containing no bait at all and the other was given the standard bait made up as follows—

Maize Meal	*Agrocide 7*	*Molasses*	*Water*
3 lb.	1 oz.	1 oz.	1 pint

Fifty adult weevils were introduced to each cage at 14.00 hours on the 31st August and mortality assessed at intervals:

TEST NO. 1—MORTALITY

Cage:	1 Control	2 Maize Meal 3:1:1	3 Cob Meal 3:1:1	4 Cob Meal 3:2·2
Date Time	0			
31/8 16·30 ..	0	32	6	22
1/9 08·30 ..	0	15	15	23
14·30 ..	1	0	4	0
2/9 08·30 ..	0	1	2	4
16·30 ..	0	0	0	0
3/9 08·30 ..	1	0	0	1
Total ..	2	48	27	50

The result shows that at the same concentration by weight, cob meal is only half as effective as maize meal. However, the material is almost twice as bulky and by doubling the insecticide and molasses the same result is achieved.

In the second series of tests it was desired to determine, (*a*) whether in the mixture using 3 lb. cob meal to 2 oz. Agrocide 7 to 2 oz. molasses, the high kill was due to the higher level of Agrocide or that of the molasses, and (*b*) by increasing the strength of the bait even more, whether a more rapid kill could be achieved.

The following cob meal baits were prepared—

Bait	Cob Meal	Agrocide 7	Molasses	Water
C.M. 3	3 lb.	1 oz.	2 oz.	1 pint
C.M. 4	3 lb.	3 oz.	3 oz.	1 pint

These were tested against a control and the standard BHC bait, all baits being applied at the rate of 15 lb. per acre. Fifty weevils were introduced into each cage at 16.30 hours on the 8th November:

TEST NO. 2—MORTALITY

Date Time	Cage: 1 Cob Meal 3:1:2	2 Cob Meal 3:3:3	3 Maize Meal 3:1:1	4 Control 0
9/9 08·00 ..	7	11	29	0
15·45 ..	5	2	7	0
10/9 08·00 ..	1	0	5	0
16·00 ..	1	4	6	0
11/9 08·00 ..	0	0	1	0
Total ..	14	17	48	0

From cage 1 it appears that the extra quantity of molasses is of little assistance by improving the palatability of the material. On the other hand, the results from cage 2 were disconcerting as one would have expected a kill equivalent to, or better than, that given by the maize meal bait. It was therefore assumed that either the bait had not been properly mixed or, alternatively the concentration was high enough for the odour to act as a repellant.

This bait was therefore repeated and also another with a higher concentration of molasses was tried—

Bait	Cob Meal	Agrocide 7	Molasses	Water
C.M. 4	3 lb.	3 oz.	3 oz.	½ pint
C.M. 5	3 lb.	3 oz.	6 oz.	½ pint

The above baits were applied at the rate of 15 lb. per acre and the weevils introduced at 15.30 hours on the 14th September:

TEST NO. 3—MORTALITY

Date Time	Cage: 1 Maize Meal 3:1:1	2 Cob Meal 3:3:3	3 Cob Meal 3:3:6	4 Control 0
14/9 16·45 ..	7	3	9	0
15/9 08·30 ..	27	28	21	0
16·00 ..	10	7	3	0
16/9 08·40 ..	2	3	2	0
17·00 ..	0	3	4	2
17/9 09·15 ..	0	2	1	4
Total ..	46	46	40	6

From these various tests, it is apparent that cob meal, if finely ground, may be substituted for maize meal as the carrier.

Further work of this nature was precluded during 1954 as the supply of weevils failed.

An observational trial, employing corn cob meal bait on a field scale, was carried out in May, 1955, against a light infestation of *Oreorrhinus glabricollis* Mshl., *Eutochia pulla* Er. and an unidentified specie of beetle, in a block of germinating seedlings at Kipkabus. These beetles are similar in behaviour to *N. perditor*.

The bait was formulated as follows—
Corn cob meal, 15 lb.;
Agrocide 7, 10 oz. weight;
Molasses, 10 oz. fluid;
Water, 2½ pints.

It was employed in comparison with the standard maize meal bait and proved to be equally effective. The grower may thus have the option of using either carrier. Corn cobs are a refractory material to grind finely, particularly in a hammer mill. It should first be ground through a ½-in. screen and then reground using a $\frac{1}{16}$-in. screen. Even so, it should be more economical than employing maize meal.

When preparing bait, the BHC powder must be added to the dry meal and mixed very thoroughly. It should be prepared in small quantities as more uniform mixing is achieved. The molasses is dissolved in the water and the solution then added to the Agrocide 7 meal-mix, a little at a time, the whole being mixed continuously. The bait should be made moist but not soggy since difficulty will be experienced in spreading in the latter event.

Effectiveness and Cost of Control

It has been shown that the maize meal/Agrocide bait can give a kill of 95 per cent and over under the following optimum conditions—

(1) During the danger period, a very sharp watch for the presence of the weevil should be maintained in all areas likely to be attacked. If the presence of the weevil has been noted within the district, a daily examination of the stands is recommended. It is of little value to wait until an attack is in full swing before applying control measures, since although it is effective, much damage will already have been done.

(2) The land should be clear of grass and weed growth.

(3) The bait should be applied to the tree lines immediately the first sign of infestation is noted.

(4) The point of entry of the pest should be found where possible, and a wide swathe of bait laid across it to provide a *cordon sanitaire.*

(5) Since the persistency of the bait depends largely upon the amount of rainfall, a careful watch must be kept to ensure that as soon as it shows signs of becoming dispersed and/or mouldy, the area should be rebaited. Under average conditions it is unlikely to be effective for more than five to eight days. Heavy rain, on the other hand, may render the bait ineffective after 24 hours.

(6) If it is known that *Nematocerus* are in the area, particularly where damaged blocks have been resown, the bait should be applied just prior to germination or, if the area has been beaten up with transplants, each clump should be enclosed by a ring of bait.

Seldom is it possible to achieve all these requirements simultaneously and hence there will almost invariably be losses of trees to a greater or lesser extent during an infestation. Careful attention to the above details will, nevertheless, go a long way to providing a satisfactory and cheap form of control.

From Table I, which gives records of the 1954 campaign on the Plateau Wattle Company Ltd.'s Uasin Gishu Estates, it will be seen that in one case as many as six baitings had to be carried out before the weevil finally disappeared, and that a large proportion of the area attacked had to be resown or patch-sown. In the case of Kipsomba Estate, not only had the whole area to be completely resown once, but a patch sowing was subsequently also necessary.

On these estates, however, many of the initial stands were extremely poor and grassy, particularly so with the Forestal Lands and Kipsomba Estates. The other areas varied considerably and it is therefore difficult to apportion, with any accuracy, the amount of resowing necessary as a result of weevil damage, and that due to a poor initial stand. At a rough estimate, the writers would divide the item on a 50/50 basis.

The two estates under closest observation by the Research Department were Outspan and Kipsomba. They provide a useful illustration of the above points.

The average infestation rate on Outspan was calculated at some 200,000 weevils per acre over much of the area. That on Kipsomba was estimated also to be in the region of 200,000 although the presence of heavy grass growth made it difficult to obtain accurate counts.

In the case of Outspan, all the initial germination was good with the exception of some 30 acres which suffered losses due to silting. Some of the acreage was interplanted with maize or wheat.

Of the 355 acres attacked by the weevil, 245 received three or more applications of bait, much of which was applied to protect patch sowings that had been carried out to fill in gaps caused by the weevil. In the final estimate, however, it is seen that only 245 acres required patch-sowing to ensure an adequate stand, and of this acreage the necessity of resowing may, in part, be attributed to the effects of silting over some 30 acres. If, however, baiting had not been carried out it is confidently expected that the wattle over the whole area would have been almost completely wiped out.

On the other hand, the infestations on Kipsomba Estate were all in an area of poor re-establishment. Initial germination was indifferent, and the area grassy. The attack occurred later in the season and ran for a shorter period, but despite three baitings over the area, the initial stand was practically wiped out, necessitating a complete resowing over 319 acres and subsequent patch-sowing again

TABLE I.—ACREAGE OF PLANTATIONS ATTACKED AND COST OF BAITING

Estate	Acreage attacked	Acreage baited and number of times						Total acreage baited	Cost per acre baited	Cost per acre attacked	Acreage completely resown	Acreage patch sown	Cost per acre sowing	Sowing cost per acre attacked	Total cost per acre attacked
		1	2	3	4	5	6								
									Sh. cts.	*Sh. cts.*			*Sh. cts.*	*Sh. cts.*	*Sh. cts.*
Forestal lands ..	386	323	63	—	—	—	—	449	4 19	4 19	—	484	2 33	2 93	7 79
Navillus ..	83	43	40	—	—	—	—	123	4 26	6 32	—	219	12 48	32 94	39 25
Kipsomba ..	319	76	86	157	—	—	—	719	4 31	9 72	319	319	10 68	21 36	31 08
Kapsaret ..	66	22	44	—	—	—	—	110	2 85	4 76	—	—	—	—	4 76
Borderlands ..	3·5	—	3·5	—	—	—	—	7	3 06	6 13	—	—	—	—	6 13
Ngeria	140	—	120	20	—	—	—	300	7 41	15 87	19	140	2 84	3 23	19 11
Outspan ..	355	28	82	167	46	32	—	1,037	5 03	14 69	—	245·5	2 17	1 50	16 19
Baron Emile ..	150	130	—	10	5	5	—	205	5 04	6 88	30	120	2 35	2 35	9 23
Kipkabus Downs	133	—	28	33	72	—	—	442	4 51	15 05	12	74	6 54	4 23	19 28
Skyline	233	76	—	157	—	—	—	547	5 40	12 69	70	35	6 01	2 71	15 39
Lolgarini ..	287	74	37	28	—	110	38	1,010	2 81	9 89	116	148	2 51	2 31	11 21
TOTAL ..	2155·5	772·0	503·5	572·0	123·0	147·0	38·0	4,950	4 46	10 25	566	178·5	5 90	6 44	16 69

over the whole area. Much of this was due to the initial state of the plantation, but it is clear from the writers' observations that the condition was seriously aggravated by the presence of the weevil and, secondly, baiting was not nearly as effective as on Outspan.

Also in Table I are shown the costs of the various operations. It will be seen that some variation exists in the actual cost of baiting per acre. This is attributed to the fact that, although a particular formula for the bait was recommended, there has obviously been some variation according to taste, also in some cases molasses was not available. Secondly, the original recommendation was that the bait should be applied at the rate of 10 lb. per acre. General experience, however, showed that it was difficult to apply in practice at this rate and the average rate worked out at 13.65 lb. per acre, although here again individual estates varied from nine to 19 lb. per acre. Similarly, the number of boy-days employed in applying the bait varied from 0·20 to 1.2. These variations are to be expected and will depend on the nature of field conditions encountered. The average cost for all the estates concerned is Sh. 4/46 per acre.

This cost, when applied to the total area attacked, will naturally show variations depending upon the number of rebaitings carried out and the proportion of the total area over which the bait had to be reapplied. This in turn is governed by the nature and intensity of the attack. In no area was it possible to bait only once, and in the case of Lolgarini and Outspan Estates five and six baitings had to be carried out, though on a diminishing scale. On the average, however, the total acreage received only two to three baitings at an average cost of Sh. 10/25.

The necessity of resowing damaged areas must be considered as an integral part of controlling the effects of the weevil. In this respect it has often been found practicable to fill in by transplanting young seedlings during a wet spell from areas where they are present in excess, this particularly applies to areas of re-establishment. Once more the costs may be expected to vary considerably and are dependent upon the state of the initial stands, as well as the effectiveness of the baiting. Kipsomba and Outspan Estates may again be compared. The resowing costs per acre are Sh. 21/36 and Sh. 1/50 respectively. The condition of the stand and effect of the weevil have mutually combined to aggravate the damage on Kipsomba Estate, whereas the clean land and good initial stands on Outspan greatly enhanced the effect of the bait, reducing the amount of damage and making resowing a comparatively simple and effective operation. To-day, the affected blocks on Outspan all have satisfactory stands, whereas those on Kipsomba remain indifferent.

The overall average cost of the campaign is shown to be Sh. 16/69 per acre of wattle attacked. It is the writers' opinion that this is a very satisfactory figure when the intensity of the weevil attacks is considered, together with the fact that in a number of instances, the conditions of the stands were already very poor when attacked. As stated before, without the remedial measures, the areas suffering attack would have been decimated and, in all probability, the damage would have spread to other areas of establishment.

Conclusions

It has been shown that under ideal conditions the Agrocide 7/maize meal/molasses bait can provide almost complete control of the *Nematocerus* weevil. However, it is seldom that all the necessary conditions can be met and thus a greater or lesser amount of damage is to be expected, particularly in poor grassy stands. It is obvious that every effort should be made to ensure that a high initial germination of seed is obtained in clean land.

It may be expected that the population and distribution of the weevil will vary greatly from year to year, and that unless effective control takes place, the attacks will tend to increase in severity with the passage of time. It is essential each year, as soon as the rains break, to keep a vigilant watch for the first signs of the weevil, and all the necessary preparations should be made beforehand to combat it immediately.

While the present form of control may be regarded as adequate, the writers would not wish to regard it as by any means the final answer. Much remains to be done, particularly with regard to improving the speed of bait applications and obtaining better coverage. Secondly, stands of wattle containing heavy weed and grass growth seem to call for a different technique, the answer to which may be found in the employment of sprays. These matters will form the basis of further investigations, the results of which, it is hoped, may warrant publication in this *Journal* at some future date.

OTHER PESTS

COLEOPTERA

Besides the weevil, *Nematocerus perditor* Mshl. a number of other pests have been encountered, but to date their activities have been on a more limited scale. Some of these have been associated with *Nematocerus perditor* or have similar habits, and will thus be described first.

PLATE 1A.—*Nematocerus perditor* Mshl. (Body length 5 mm.)

Nematocerus sp. indet. (Curculionidæ).—This species is not represented in the British Museum. It is very similar to *Nematocerus perditor*, but the abdomen is generally longer and narrower. The total length of the insect slightly exceeds 6 mm. although the width across the broadest part of the abdomen is only about 2 mm.

PLATE 1B.—*Nematocerus* sp. (Body length 6 mm.)

During August, 1953, some 50 acres of wattle on Lolgarini Estate in the Kipkabus area were attacked by this pest which caused serious defoliation, resulting in the death of a number of young trees. The outbreak was controlled using a bait of—

1 oz. BHC 2.6 per cent gamma,

3 lb. chopped green maize stalks.

Elsewhere it has been observed in small numbers associated with *Nematocerus perditor* and is susceptible to the standard BHC/maize meal bait.

Oreorrhinus glabricollis Mshl. (Curculionidæ).—A glossy black weevil some 10 mm. long with an extremely bulbous abdomen about 5 mm. broad.

PLATE 2A—*Oreorrhinus glabricollis* Mshl. (Body length 10.5 mm.)

Speciments of the pest were first recovered from the Kipkabus area during August and September, 1953, from newly-planted wattle some four to five months old. Defoliation had resulted from these attacks, but was not considered sufficient to warrant the application of control measures. During March, 1954, further specimens were collected from Gara Falls Estate, but the numbers were small and caused little or no visible damage. During

June, 1954, damage by *Nematocerus* weevil was reported by the Superintendent, Skyline Estate, in the Kipkabus area. On inspection, however, it was found that *Nematocerus* weevil were present only in very small numbers, and that the damage was being caused by an outbreak of *O. glabricollis*. This outbreak, together with a further light infestation during May, 1955, in the Kipkabus area, was successfully controlled by employing the standard BHC/maize meal bait and a similar bait, using corn cob meal.

Tanymecus laminipes Mshl. (Curculionidæ).—This weevil was found to be causing severe damage to new plantings on Ngeria Estate and was largely responsible for heavy damage to the young wattle. Here again, the standard *Nematocerus* weevil bait provided an effective control.

PLATE 2B.—*Tanymecus* sp. (Body length 10.5 mm.)

Gonocephalum simplex F. (*Dásus simplex* F.) (Tenebrionidæ).—A flat beetle approximately 11 mm. long by 5 mm. in width; the back is covered with minute bristly hairs to which soil adheres, giving the insect a brown dusty appearance.

This pest has been responsible for appreciable damage to a number of plant species, particularly seedling maize. It is not generally believed to be dangerous to wattle, but did cause some damage to late planting on Outspan Estate at the onset of a dry season when other moist plant material became scarce. *Gonocephalum* may be controlled by the standard bait.

PLATE 3A.—*Gonocephalum* sp. (Body length 11 mm.)

PLATE 3B.—*Eutochia pulla* Er. (Body length 7.5 mm.)

Schizonycha sp. (Melolonthidæ).—A small chafer beetle some 15 mm. long by 6 mm. broad, light brown in colour. This species of chafer grub has been recorded by the Agricultural Department, Kenya, as a serious pest of maize and other crops [4]. Our first record of damage to wattle by this pest occurred on Lolgarini Estate in June, 1953, in re-established wattle approximately three months old. Counts taken varied between 49 and four larvæ per square yard. It appeared that populations along the wattle rows were generally lower in grassy areas. The young wattle plants were growing away from the infestation and control measures were not implemented.

During August of the same year a far heavier outbreak occurred on Skyline Estate in a late sowing of wattle. Unfortunately, the outbreak was not noted until the young plants had suffered considerable damage. Some 70 acres of wattle were attacked, and when seen by the writers presented a very patchy appearance. Replanting was commenced almost immediately and a BHC (0.65 per cent gamma) dust was applied at the rate of 30 lb. per acre along the rows of wattle and hoed in. Since this replanting was necessarily carried out very late in the season, casualties from drought were high, but some 40 acres survived.

PLATE 4A.—*Megalognatha meruensis* Wse. (Body length 9 mm.)

In the wattle plantations of Southern Rhodesia, a chafer grub (*Eulipeda mashona* Arrow) has proved to be an extremely serious pest. Much energy has been devoted to its control both in the larval and adult stages. It has been shown [5] that the application of at least 22 lb. of 0.45 per cent gamma BHC per acre in strips along the wattle lines provides a reasonable protection. The standard rate now employed in these areas is 30 lb. of 0.5 per cent gamma BHC [6].

Megalognatha meruensis Wse. (Galerucidæ).—These beetles vary greatly in size, averaging 9 mm. by 3 mm. The colour is predominantly dull black, having a yellow and black abdomen protruding beyond the elytra.

Megalognatha aenea Lab. (Galerucidæ).—An iridescent bronze coloured beetle about 7 mm. long by 3 mm. broad, and otherwise fairly similar to *M. meruensis*.

PLATE 4B.—*Megalognatha aenea* Lab. (Body length 7 mm.)

Megalognatha cyanipennis Wse. (Galerucidæ).—A beetle very similar to *M. ænea* except in its colour which is a metallic blue.

These are small leaf-eating beetles, common in the Uasin Gishu, Trans Nzoia and Sotik districts. They have been observed to cause severe defoliation to young wattle up to two years of age. Outbreaks to date have been limited to relatively small acreages, the largest infestation recorded covered 25 acres of 12-month-old trees in the Trans Nzoia in 1954.

The same plantation suffered heavy reinfestation in May, 1955, and many trees 20 ft. in height were completely stripped of all leaf.

A 25 per cent DDT emulsion, applied at the rate of three pints to 60 gallons water per acre, gave effective control. Dusting with 10 per cent DDT dust at 15 lb. per acre also gave rapid and effective control. Agrocide 3 dust (0.65 per cent gamma BHC) applied at the rate of 30 lb. per acre, although having a slower knock-down, neverthless provides satisfactory control.

This pest has also been found to be sensitive to Dieldrin at low concentrations although an immediate knock-down is not obtained.

HEMIPTERA

Wattle Froghopper.—The term "wattle froghopper" refers to a complex of insects, within the order Hemiptera, which are principally represented by the families Jassidæ and Miridæ. They are sucking insects which live off the juices of the tree and cause damage by introducing some toxic substance to the tree which ultimately produces an effect known as "witches broom" from which heavy branching results when normal tree growth is resumed.

The froghopper complex is a particularly widespread pest in Kenya, having been observed in all the principle wattle-growing areas of the Colony. From general observation it is thought that some apppreciable loss of growth increment occurs during the period of attack. In the case of severe attacks, the trees become badly stunted and deformed with the production of multiple leaders. Pruning becomes necessary and the selection of trees for the final stand is impaired. In windy areas the tree may suffer subsequently from broken branches and leaders.

To date the six species of wattle froghopper given below have been isolated and identified by the British Museum, and other species await identification.

Lygidolon lævigatum Reut. (Miridæ).—A small sucking insect about 4 mm. long by 1½ mm. broad, translucent yellow brown in colour with a black triangular marking on the thorax.

Lygus sp (Miridæ).—Similar to *L. lævigatum* but slightly longer (about 5 mm.) and colour generally a deeper red.

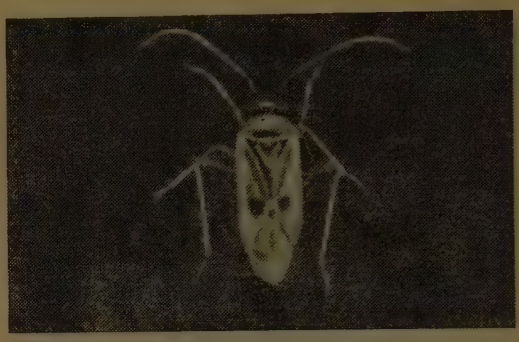

PLATE 5A.—*Lygus* sp. (Body length 4 mm.)

Jassus subolivaceus Stal. (Jassidæ).—Adults vary greatly in size, averaging 3 mm. but rarely exceeding 6 mm. in length. Triangular in appearance when observed from above. The width across the shoulders is about half the length. These insects are pale green in colour.

Jassus sp. (Jassidæ).—Similar to *J. subolivaceus.*

PLATE 5B.—*Jassus* sp. (Body length 5.5 mm.)

Selenocephalus sp. (Jassidæ).—Colour of specimens vary from a light brown to grey-black, approximately 4 mm. long by 1.5 mm. broad.

Oxyrhachis sp. (Membracidæ).—Generally larger than *Jassus subolivaceus,* brown in colour, triangular in shape, and having two horns on the shoulders of the body, and the tail continued beyond the wings in the form of a spur.

In October, 1953, specimens of each of *L. lævigatum, J. subolivaceus* and *Oxyrhachis* were isolated and introduced into sleeves containing healthy young wattle plants. When examined in February, 1954, the trees infested with *Jassus subolivaceus* showed typical signs of froghopper damage. Those infested with

Lygidolon appeared perfectly healthy but no living specimens of the pest were recovered from any of the trees.

Oxyrhachis, often termed "Australian froghopper", in one instance produced effects similar to froghopper damage. Field observations indicate that this creature plays a very minor role.

Little is known of the life cycle of the complex. Infestations begin to appear on the Uasin Gishu in young wattle towards the close of the rainy season, that is, September and October. Longish dry spells in June, July and August have also produced infestations. The tender growing crown of the tree is stung, producing an atrophied appearance and a certain amount of leaf fall. It is only later, between December and March, when the infestations slacken off and the trees commence to grow again, that the main effect is to be observed. Numerous shoots are developed in the affected regions resulting in the heavily tufted stems characteristically described as "witches broom". The better the growing conditions, the more pronounced the effect.

The tree is susceptible to attack between one and three years of age and it is thought that in areas of the Central Province severe attacks may continue into the fourth and even fifth year.

The annual appearance of this pest is a common and expected feature over the wattle-growing areas of the Uasin Gishu, but to date the only method of controlling its effect has been to prune the trees of multiple leaders where necessary, up to a height of nine to 10 ft. Damage above this point cannot be reached easily and is thus usually left. It is a moot point whether chemical control of the pest would be economical except under exceptionally severe cases of attack. In the Union of South Africa, a closely related froghopper complex has been known for many years [5], [7], and is composed of the species *Bythoscopus cedaranus* Naude and *Lygidolon lævigatum* Reut.

Ripley and Petty (1940) demonstrated that control may be achieved by dusting the trees with pyrethrum dust [7]. Later work [7] has shown that effective control may be achieved by fogging with 1 per cent oil solution of Toxaphene at three gallons per acre; 4 per cent gamma BHC at 0.3 gallons per acre and by pressure spraying with a 1 per cent oil solution of Toxaphene at two gallons per acre.

During September, 1954, an area of 25 acres of 15-month-old trees in the Trans Nzoia was sprayed, using three pints 25 per cent DDT emulsion in 60 gallons of water per acre. Complete control of the froghopper was achieved for six weeks; thereafter a few froghopper were noted. Prior to this date the trees had been suffering severe and continual attack for a period of some eight months. Growth had been almost completely halted and severe deformation of the trees was taking place. Within a very short period of the spraying normal growth was resumed. Pruning of the trees was necessary and within three to four months they had regained a reasonable form. Furthermore, a stand of five-month-old trees adjacent to the area was also becoming infested. These were sprayed at the same time and subsequently remained completely free of the pest.

The spraying cost was Sh. 30 per acre and it is considered to have been fully justified in this instance. Without spraying, the attack in the 15-month-old stand would have continued into January or February and the adjacent five-month-old trees would also have become heavily infested over the same period.

This example is quoted in some detail since it is illustrative of conditions under which insecticidal control measures are justified. General spraying of all froghopper infestations cannot be recommended in the present state of our knowledge on the subject, since (*a*) the full effects of damage have not been accurately assessed to date and in any event, will vary considerably according to the intensity of infestation, and (*b*) indiscriminate spraying of any type is not to be recommended since it may well have an adverse effect upon the biological equilibrium, particularly with regard to natural predators.

One method that can be recommended to allay partially the effects of moderate froghopper infestations is to delay the time of final espacement until the trees are well into the second season of growth. The principal danger period, i.e. between nine and 22 months, has then been passed. The higher stands so obtained partially counteract the tendency of the tree to become bushy after an attack, by forcing the growth upwards. This, combined with judicious pruning to remove multiple leaders, will generally serve to produce a satisfactory final stand.

LEPIDOPTERA

Saturniidæ	*Gynanisa maia* Klug.
	Nudaurelia tyrrhea Cram.
Geometridæ	Sp. unidentified (looper caterpillar).
Limacodidæ	*Cœnobasis albiramosa* Walk.
Lasiocampidæ	*Gonometa postica* Walk.
	Pachypasa fulvida Dist.
Lymantridæ	*Argyrostagma niobe* Weym.
Psychidæ	*Clania cervina* Druce.
Noctuidæ	Sp. unidentified (cutworm).

Sporadic outbreaks of the above have been observed to cause damage to wattle by defoliation, usually in the later years of growth.

The Saturniidæ larvæ were recorded at Sotik in 1951 where a block of eight- to nine-year-old trees had been completely stripped of all leaf. Subsequently, the trees recovered satisfactorily. A similar, but smaller, outbreak was observed elsewhere in the area at the same time. No further infestations of this species have been recorded.

In May, 1954, an infestation of a "looper" caterpillar (Geometridæ) was reported in mature trees of the Plateau Wattle Company Ltd's. Estates in the Turbo district. Some 28 acres on Selborne and five acres on Stanley Estates were affected. Severe defoliation occurred and difficulty was experienced in stripping. The infestation rate was calculated to be approximately 500 larvæ per tree. Attempts were made to control the caterpillar by dusting the trees with a 0.04 per cent gamma BHC powder and a 10 per cent DDT dust. The trials were, however, unsuccessful as the machine employed could not get the dust into the crown of the trees.

During June, 1953, a report was received of an infestation of *Cœnobasis albiramosa* on the Plateau Wattle Company Ltd's. Kapsaret Estate. Some 20 to 30 acres of trees being stripped were found to be affected. Sample trees showed infestation rates of from 10 to 500 larvæ per tree. Defoliation was light and the principle trouble caused by the pest was amongst the strippers. The insect has a very painful sting and the labourers, quite naturally, did not relish being showered with the caterpillar when felling the trees. No control measures were attempted in this instance.

Two species of Lasiocampids and various other Lepidoptera larvæ have been noted in plantations and have a fairly wide distribution. Many appear to be heavily parasitised which augurs well for the possibilities of biological control.

It is expected that when climatic conditions are favourable, spasmodic outbreaks of pest proportions may occur with the members of this order. Under certain circumstances chemical control may be necessary to enable operations such as stripping to be performed or to prevent a serious loss of increment, otherwise it is probable that natural predators will generally suffice to keep population numbers in check.

Clania cervina Druce (Psychidæ), the "Lictor" bagworm has been observed on wattle throughout the Plateau areas. Although nowhere has it assumed a pest proportion, it is mentioned here since this subject looms so large in South African wattle entomology. In Natal particularly [7], [8], thousands of acres each year suffer a greater or lesser degree of defoliation from attack by another bagworm, *Acanthopsyche junodi* Heyl. The main form of control is by aerial spraying employing Toxaphene in oil solution. Benzene Hexachloride and Endrin have also been employed [5], [9].

The insect is under observation in Kenya and annual surveys have been instituted to cover the 45,000 acres of the Plateau Wattle Company Ltd.'s plantings in the Uasin Gishu in order to provide some indication of its progress. These surveys cannot be carried out in any great detail at present and it is thus possible that odd infestation pockets may be missed. The sampling is, however, carried out at random over all the districts and it is calculated that requisite warning will be received if a build up in population is taking place.

Cutworm.—Attacks on young wattle by larvæ of a Nactuid moth were reported from the Plateau Wattle Company Ltd's. Skyline and Outspan Estates during August and September, 1954. Some 66 acres on the first estate suffered severe damage, but on Outspan, the outbreak, although covering a total area of 120 acres, was very patchy.

Both attacks occurred in old wheatland. On Skyline the wattle was interplanted with wheat. The soil in such areas has a very fine tilth and provides ideal conditions for breeding.

The Noctuid larvæ largely feed on the surface during the dark hours and lie up in

burrows in the daytime. The following bait was applied at 15 lb. per acre—

4 lb. Agrocide 7 (2.6 per cent gamma BHC),

100 lb. maize meal,

30 oz. molasses.

At the same time the area was resown. The bait proved reasonably effective, providing adequate protection. As usual, it had to be renewed a number of times.

Agrocide 3 dust (0.65 per cent gamma BHC) was also applied to a small plot of seedlings at the rate of 40 lb. per acre. Control in this plot was effective in that a good stand was ultimately achieved.

The area was almost inaccessible during August and September due to heavy rains and investigations were therefore restricted.

AN ANNOTATED LIST OF INSECTS SO FAR FOUND IN KENYA WATTLE PLANTATIONS

DERMAPTERA:

Forficulidæ:

Forficula senegalensis Serv. 57*.—Found under bark of dead or dying trees. No economic importance.

ISOPTERA:

Termitinæ:

Cubitermes sp. 19.—Common in virgin land on the Uasin Gishu. Builds small anthills one to two feet high and three to four feet diameter. Rare in wattle plantations but occurs in establishment when land poorly broken. Has not been observed to damage trees.

HEMIPTERA:

Pentatomidæ 82.—Larvæ of members of this family have been found on wattle at Turbo and Kipkabus. No damage observed.

Miridæ:

Lygidolon lævigatum Reut. 45.—Plentiful in wattle throughout Uasin Gishu and Central Province. Occurs in association with *Jassus subolivaceus* Stal. Associated in South Africa with *Bythoscopus cedaranus* Naude. in froghopper complex.

Lygus sp. 120.—Found in wattle in the Limuru district.

Tettigometridæ:

Hilda sp. 56.—A small brown "froghopper", not considered serious as a pest.

Cercopidæ:

Ptyelus grossus Fabr. 79.—Widespread throughout Plateau wattle-growing areas. No economic importance at present.

Membracidæ:

Bocchar sp. 81.—Found in wattle at Kipkabus, Soy and Turbo. No economic importance at present.

Oxyrhachis sp. 47.—Often called "Australian froghopper". Attended by ant, *Crematogaster* sp. Can cause "witches broom" and light gummosis in wattle. Not considered serious.

Centrotus sp. 91.—No economic importance at present.

Jassidæ:

Jassus subolivaceus Stal. 41.—Associated in Kenya with *Lygidolon lævigatum* Reut. in froghopper complex.

Jassus sp. 122.—Found in wattle in the Limuru district.

Colobothrus bellicosa Dist. 42.—No economic importance at present.

Selenocephalus sp. 121.—Found in wattle in the Limuru district.

Euscelis sp. 50.—Very light distribution. No economic importance at present.

Coccidæ:

Coccus hesperidum L. 20.—Found in very large numbers on one tree only in Nandi border. Not at present considered to have economic importance.

Ceroplastes ? africanus Sign. 22.—Found in Nandi, Soy and Turbo districts, usually on unthrifty trees. Stated by Delotto to be capable of killing wattle. At present not serious. Possibly parasitised by *Epimadiza rugosa*.

Icerya maxima Newst. 174.—Isolated infestations in Turbo district. No damage observed.

Icerya purchasi Mask. 40.—Common in all wattle-growing areas. Attacks generally very localised. Usually cleared up by indigenous *Coccinellid* beetles. Not considered serious but, if necessary, may be controlled by following spray which, however, also kills beneficial insects: 1 pint alboleum, 1 fl. oz. nicotine sulphate, 4 gal. water.

Plataspidæ:

Plataspis sp. 85.—In an unthrifty stand of wattle. Turbo district.

LEPIDOPTERA:

Geometridæ:

? Gen. et sp.—Larvæ defoliate wattle; can be serious.

Saturniidæ:

Gynaisa maia Klug. 175.—Larvæ defoliate wattle; can be serious.

Nudaurelia tyrrhea Cram. 109.—Defoliating wattle. Kipkabus area.

Psychidæ:

Clania cervina Druce. 4.—Wide distribution throughout the Uasin Gishu; at present not serious as a pest, probably parasitised by *Elasmus* sp. nr. *johnstoni* Ferr.

Limacodidæ:

Cœnobasis albiramosa Walk. 21.—Larvæ defoliate wattle. Sting very painful. Parasitised by *Eurytoma* sp.

* Collection number.

Lasiocampidæ:

Gonometa postica Walk. 1.—Larvæ defoliate wattle. No economic importance at present. Heavily parasitised by *Sturmia* (*Prosturmia*) sp., *Meteorus* sp., *Theronia lurida* Tosq., *Pimpla mahalensis* Grib.

Gonometa drusei Bak.—Reported in Limuru area.

Pachypasa fulvida Dist. 9.—Observed in Nandi district. Said to cause severe defoliation. Not yet serious. Parasitised by: *Disophrys capensis* Szepl., *Sturmia* (*Prosturmia*) sp.

Noctuidæ:

Achæa thermopera Hmps. 15.—Fairly numerous pupæ on individual trees in Turbo district. Pest propensities undetermined. Parasitised by *Echthromorpha variegata* Brulle.

? Gen et sp.—Larvæ damaged wattle seedlings at Ainabkoi.

Lymantriidæ:

Argyrostagma niobe Weym.—Attacks by larvæ have resulted in complete defoliation of large acreages of mature trees in the Turbo area.

COLEOPTERA:

Cucujidæ:

Læmophlæus sp. 67.—Stem borer found in an unthrifty stand of wattle in the Turbo district.

Coccinellidæ:

Rodolia picicollis Wse. 102.—Predator of *Icerya purchasi* Mask. Sotik district.

Bostrychidæ:

Xyloxosocus sellatus Fahr. 65.—In an unthrifty stand of wattle. Turbo district.

Xyloperthodes castaneipennis Fahr. 70.—Boring in unhealthy plantation in Turbo district.

Apate monachus F. 105.—Boring in stems of wattle trees of approximately two years of age, in an area where the bark had been damaged by hail. Turbo district.

Buprestidæ:

Chrysobothris dorsata F. *Agrilus* sp.—Stem borers also found in an unthrifty stand of wattle. Turbo district.

Telephoridæ: (Cantharidæ)

Afronycha sp. 63.—Found in Nandi district. Of no economic importance.

Tenebrionidæ:

Lyphia sp. 66.—Unhealthy stand of wattle. Turbo district.

Eutochia pulla Er. 97.—Destroying newly germinated wattle seedlings. Kipkabus district.

Gonocephalum simplex F. (*Dasus simplex* F.).—Light damage to late planted wattle. Nandi district.

Gonocephalum prolixum Er. 116.—Not a serious pest, causing only light damage to young wattle in Kipkabus district.

Gonocnemis sp. ? *strigipennis* Thoms. 73.—In an unthrifty stand of wattle. Turbo district.

Lagriidæ:

Chysolagria purpurascens Bor. 28.—A few specimens found causing defoliation. Not of economic importance at present.

Galerucidæ:

Megalognatha meruensis Wse. 27.—Causes severe defoliation in young wattle which can result in killing or retardation of growth. Outbreaks, so far, small and scattered. Adults plentiful June to July. DDT, BHC, Lindane, Dieldrin and Toxaphene have been shown to control *Megalognatha meruensis* at fairly low concentrations.

Megalognatha ænea Lab. 29.—Found near Sotik causing severe defoliation to young wattle in Kipsigis Reserve. Also found in Trans-Nzoia.

Megalognatha cyanipennis Weise. 117.—Causing severe defoliation to wattle in Kitale district. Controlled with DDT emulsions or dusts.

Monolepta sp. 48.—Small beetle, plentiful in Nandi border district. Not observed to damage wattle.

Curculionidæ:

Nematocerus perditor Mshl. 25.—Causes severe and widespread damage to young wattle.

Nematocerus sp. 26.—Causes damage similar to *Nematocerus perditor* Mshl., less widespread.

Oreorrhinus glabricollis Mshl. 53.—Damage similar to *Nematocerus perditor* Mshl., less widespread.

Tanymecus laminipes Mshl. 95.—Damaging young wattle seedlings in Nandi border area.

Tanymecus sp. 115.—Causing light damage to young wattle in Kipkabus area, also to maize in Hoey's Bridge district.

Lobotrachelus sp. n. 55.—Recovered from an unthrifty stand of wattle. Turbo district. No economic importance at present.

Camptorrhinus vulturnus Mshl. 71.—In an unthrifty stand of wattle. Turbo district. No economic importance at present.

Melolonthidæ:

Schizonycha sp. 18.—Larvæ in soil, damaging roots of young wattle.

Acerica sp. nr *lucidula* Per. 104.—Damage similar to *Schizonycha* sp.

Rutelidæ:

Popillia sp. nr. *æneipennis* Ohaus. 119.—Defoliating young trees in the Limuru district.

Dynastidæ:

Heteronychus andersoni Jack. 111.—Causing damage to young wattle. Kipkabus district.

Clytridæ:

Peploptera sp. nr. *suturalis* Clav. 49.—Plentiful in wattle—no evidence of damage to date but no doubt eating foliage.

Eumolpidæ:

Syagrus flavescens Brv. 51.—Found in fairly large numbers. No visible damage to wattle at present.

Rhembastus sp. 84.—Found in Turbo district. No economic importance at present.

HYMENOPTERA:

Ichneumonidæ:

Goryphus sp. 36.—Parasite ex. Lepidoptera pupa (unidentified).

Pimpla mahalensis Grib. 54.—Parasite ex. *Gonometa postica* Walk.

Theronia lurdia Tosq. 37.—Parasite ex. *Gonometa postica* Walk.

Echthromorpha variegata Brulle. 34.—Parasite ex. *Achæa thermopera* Hmps.

Braconidæ:

Meteorus sp. nr.. *lipsis* Nixon. 32.—Parasite ex. *Gonometa postica* Walk.

Disophrys capensis Szepl. 39.—Parasite ex *Pachypasa fulvida* Dist.

Merinotus capensis Cam. 86.—Bred from pupa found in wattle wood damaged by borers.

Eurytomidæ:

Eurytoma sp. 33.—Parasite ex. Lepidoptera sp. indet.

Eurytoma sp. (not *acaciæ* Risbec) 52.—Parasite ex. *Coenobasis albiramosa* Walk.

Elasmidæ:

Elasmus sp. nr. *johnstoni* Ferr. 107.—Probably primary parasite of *Clania cervina* Druce.

Eulophidæ:

Pediobius (= Pleurotropis) sp.—Possibly hyper parasite of *Elasmus* sp. or perhaps primary parasite of *Clania cervina* Druce.

Formicidæ:

Crematogaster (*Acrocœlia*) sp. very near *castenea* Sm. 44.—Attendant on *Oxyrhachis* sp.

Scoliidæ:

Tiphia sp. 46.—Small black wasp apparent in large numbers in young wattle; Nandi border district, probably parasitic.

DIPTERA:

Tachinidæ:

Sturmia (*Prosturmia*) sp. indet. 6.—Parasite ex. *Gonometa postica* Walk.

Sturmia (*Prosturmia*) sp. near *patruelis* Mesn. 38. —Parasite ex. *Pachypasa fulvida* Dist.

Chloropidæ:

Epimadiza rugosa Meij. 31.—Possibly parasitizing *Ceroplastes* ? *africanus* Sign.

DIPLOPODA:

? gen. et sp. 35.—Millipede causing damage to young seedlings.

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MUNINGA (PTEROCARPUS ANGOLENSIS D.C.) IN THE WESTERN PROVINCE OF TANGANYIKA

III—YIELDS, YIELD CONTROL, AND MANAGEMENT

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(Received for publication on 16th August, 1955)

Yields and Yield Control

Past Yields

Precise information relating yields to small areas of woodland is not available. General figures for the Western Province, derived from annual reports, are as follows:—

Year	Amount	Year	Amount
	cubic ft.		*cubic ft.*
1933 }	Not available	1943 ..	267,609
1934 }	but less than	1944 ..	303,306
1935 }	100,000 c. ft.	1945 ..	205,974
1936 }	a year	1946 ..	142,632
1937 ..	3,569 trees or	1947 ..	364,703
	90,000 c. ft.	1948 ..	600,186
	(approx.)	1949 ..	649,659
1938 ..	118,603	1950 ..	637,925
1939 ..	147,267	1951 ..	720,142
1940 ..	104,500	1952 ..	573,614
1941 ..	69,903	1953 ..	490,409
1942 ..	37,514		

In addition, during the war years a certain amount was cut as railway sleepers and for some time quite considerable stealing of muninga has been taking place. The total exploitation for the past 20 years is estimated at 6,000,000 H. ft. under bark. Long-distance haulage over 80 miles has been economic only for the past five years.

Of the Western Province, the Tabora district as it now stands has provided over 90 per cent of the total cut. The actual productive area of the district's woodland is assessed at 15,000 square miles, of which 6,000 square miles have been heavily cut over and the remainder exploited in varying intensity. The yield therefore has averaged from 25–30 cu. ft. a square mile in heavily exploited areas and 5–15 cu. ft. a square mile in the more distant areas.

Present Yields

The ordinary woodland sawmill having a maximum capacity of 100 tons sawn timber a month cuts over its accessible areas of approximately 750 square miles in two to three years. In the past five years six such mills working in the main concession areas have cut about 2,500,000 H. ft., i.e. at the rate of 25–30 H. ft. a square mile a year. A certain amount of pit-sawn timber has been produced at the same time and since it is less restricted by transport difficulties the rate of cutting is probably higher per square mile but more patchy in operation.

Most of the Tabora district is now under a simple form of yield control. A permissible annual cut has been calculated for each concession area by a form of the Brandis method, and yields of 37.5 cu. ft. to 23 cu. ft. per square mile are prescribed with no restriction as to the area in which they may be cut. A further area is controlled by a nominal yield of 1,000 trees a year, equivalent to 8 H. ft. a square mile.

Future Yields and their Calculations

It is desirable that yield control should be applied in at least a simple form to all woodland producing muninga timber and in particular to all areas which may form part of the future forest estate. A comparison of various yield calculations is given hereunder to show the basis from which the future control is prescribed.

Yields may be determined by area or by volume or a combination of both.

Yield by Area

Sections of the woodland are allotted to the several periods of the rotation, a period being anything from one year upwards, and the whole area being cut over at least once during the rotation. With concession agreements for periods of 10 or 15 years, the period of a coupe could conveniently be of the same duration. The actual yield to the square mile will vary with what is actually present on the ground, from 0–200 (average 38.4) trees per square mile. Periodic yields may be roughly equal in quantity.

Yields by Volume

These yields fall into three classes, based on growing stock, increment, or both.

Based on Growing Stock (G.S.).—Using the theory that the growing stock reproduces itself

twice in the space of a rotation, then it is permissable to remove the equivalent of the existing stock in every half-rotation and still leave the original amount.

Therefore the annual yield would be 18/80 cu. ft. = 0.225 cu. ft./acre or 144 cu. ft. a square mile if the growing stock is 18 cu. ft. an acre and the rotation 160 years. The point in doubt is that we do not know whether the G.S. does reproduce itself thus or not.

Based on Increment.—These formulæ require the calculation of mean or current annual increments (M.A.I. or C.A.I.). Theoretically one can remove the annual increment and still retain the basic amount of the growing stock. Calculations have given the M.A.I. as 0.625 per cent and the C.A.I. as 1 per cent (e.g. Ichemba). Thus the annual yield can vary between 18 × .00625 and 18 × .01, i.e. 0.1125 and 0.18 cu. ft. an acre or 72 and 115 cu. ft. a square mile.

Based on Growing Stock and Increment.—This is the largest group of methods and in many cases requires the calculation of a normal stand. Very little is known regarding normality in this type of forest and a theoretical normal is difficult to calculate since there are no yield tables. The nearest approach to normal conditions is to consider that half of an area is fully stocked with trees of just exploitable girth. Since a 15-in. Q.G. tree occupies 45 ft. × 45 ft. in crown diameter and muninga constitutes 10 per cent of the total growing stock, the normal condition would be

$$\frac{21780}{10} \div 45^2 = \frac{21780}{20250} = 1.075 \text{ trees an acre.}$$

The volume would vary directly with the average timber height of the tree for the locality. The average height of 12.5 ft. and B.H.Q.G. 15 in. gives a volume of 17.5 H. ft. Thus the average normal condition is 1.075 trees or 18.8 H. ft. an acre.

The Swiss method gives a short-term yield based on the C.A.I. and the volume of the oldest classes. With a G.S. of 18 cu. ft. an acre, C.A.I. 0.75 per cent and the volume of old trees 0.7 cu. ft. the period during which the old trees may be removed is

$$\frac{0.7}{18 \times 0.75\%} = 5.2 \text{ years.}$$

The annual yield therefore is

$$\frac{0.7}{5.2} = 0.135 \text{ H. ft. an acre or } 86.4 \text{ H. ft. a square mile.}$$

This method can be applied in more detailed manner by dividing the G.S. into immature, mature, and overmature classes with separate C.A.I., e.g. immature G.S. 17.3 cu. ft., mature G.S. 0.50, overmature 0.20 and C.A.I. 0.8 per cent, 0.5 per cent and 0.2 per cent respectively.

Therefore period of removal =

$$\frac{0{\cdot}5+0{\cdot}2}{0{\cdot}138+0{\cdot}002+0{\cdot}000} = \frac{0{\cdot}7}{0{\cdot}140} = 5 \text{ years and}$$

the annual yield $= \frac{0{\cdot}7}{5} = 0{\cdot}14$ H.ft. an acre or 90 H.ft. a sq. mile.

The Austrian method is based on the formulae,

$$\text{normal G.S.} = \frac{\text{rotation}}{2} \times \text{M.A.I. and annual yield}$$

$$= \text{M.A.I.} \times \frac{\text{actual volume—normal volume}}{\text{rotation}}$$

with an actual volume of 18 cu. ft., normal volume of 18·8 cu. ft., M.A.I. of 0·625 per cent and rotation of 160 years.

$$\text{Annual yield} = 0{\cdot}1125 + \frac{(18-18{\cdot}8)}{160} = 0{\cdot}1075$$

H. ft./acre or 68·8 H.ft./sq. mile.

Other methods are based on the same principles but use C.A.I. instead of M.A.I. and different periods to adjust the deficit of old trees. Some methods take into consideration only those size classes equivalent to ages greater than half of the rotation. The yields vary from 60 to 150 cu. ft./square mile.

The French method, a non-formula method, divides the growing stock into old, medium and young G.S. and the old G.S. is removed during one-third of the rotation. The proportion of old to medium G.S. should be 5/3, and adjustment to the yield can aim at getting these proportions. Taking 15-in. Q.G. as exploitable size, old G.S. = 10 in. and over, medium 5 to 10 in., e.g. actual G.S., old G.S. = 5.54 cu. ft., medium 10.50 cu. ft. Correct proportion old G.S. = 10 cu. ft., medium = 6 cu. ft.

Annual yield = 5.54 cu. ft. + increment for half period ÷ period
= 5.54 + (5.54 × .005 × 27) ÷ 54
= 6.14 ÷ 54 = 0.114 cu. ft./acre or 73 cu. ft./square mile.

Adjustment for deficit of $0.114 \times \frac{5.54}{10} =$ 0.063 cu. ft./acre or 40.32 cu. ft./square mile.

The Indian method uses the theory that a certain number of trees reach exploitable size each year or period of years and these may be removed during that time. The G.S. is divided into girth classes and the percentage of trees passing into the next class is estimated. Thus the number of trees passing from the lowest class to exploitable size in the course of the rotation plus exploitation period can be calculated and transformed into an annual yield:—

	e.g. Q.G. Class							
	4–6 in.	6–8 in.	8–10 in.	10–12 in.	12–14 in.	14–16 in.	Over 15 in.	Total
No. of trees ..	2·22	1·23	0·51	0·21	0·13	0·06	0·03	4·39
% Survival	20	40	55	70	85	95	95	
Trees ..	0·444	·492	·281	·147	·111	·057	·028	1·560

Rotation 160 years. Period of exploitation 20 years. Average annual yield=

$$\frac{1{\cdot}560}{160+10} = \frac{1{\cdot}56}{170} = \begin{matrix}\cdot009 \text{ trees/acre.}\\ 5{\cdot}76 \text{ trees/sq. mile.}\end{matrix}$$

For this yield Class 1 (over 15 in.) should have

$$\cdot009 \times \frac{20}{2} \times 1{\cdot}025 = \cdot092 \text{ trees/acre.}$$

There is a deficit of 2/3 of this amount, therefore the yield should be $\frac{.009}{3} = .003$ trees/acre or 1.92 trees/square mile.

A diameter (or girth) class method devised by Hufnagel also makes full use of the actual amounts of increment in these (girth) classes. This formula is:—

Annual yield=

Vol. of trees over ½ rotation age+C.A.I. for ½ rotation

Therefore annual yield $= \frac{9{\cdot}01+(\cdot09\times40)}{80} = 0{\cdot}16$ cu.ft./ ½ rotation

acre or 102·4 cu .ft./sq.mile.

Using ages instead of C.A.I. the formula becomes:—

Annual yield=

$$\frac{N_5}{A_5-A_4}V_5+\frac{N_4-N_5}{A_5-A_4}V_4+\frac{N_3-N_4}{A_4-A_3}V_3+\frac{N_2-N_3}{A_3-A_2}V_2+\frac{N_1-N_3}{A_2-A_1}V_1$$

N=No. of trees per class, V=average volume per tree, A=average age of class.

$$=\frac{\cdot04}{15}\times19{\cdot}0+\frac{\cdot05-\cdot04}{14}\times16{\cdot}0+\frac{\cdot13-\cdot05}{17}\times13{\cdot}2+\frac{\cdot21-\cdot13}{15}\times10{\cdot}0+\frac{\cdot51-\cdot21}{18}\times7{\cdot}0$$

$$=\cdot051+\cdot011+\cdot062+\cdot053+\cdot117$$

$$=\cdot294 \text{ cu. ft./acre or } 188 \text{ cu. ft./sq. mile.}$$

The Brandis method was devised in India for forests nearer in type to the Miombo woodland than are the European forests for which most yield formula were devised. The method follows the theory of the Indian method but in more detailed application. Calculations are as follows:—

Q.G. Class	No. of Trees	Survival %	Reduced No. of Trees
CASE A—			
I Over 15 in. ..	·04	95	·038
II 12 in.–15 in. ..	·18	85	·153
III 9 in.–12 in. ..	·38	70	·266
IV 6 in.– 9 in. ..	1·57	50	·785
V 3 in.– 6 in. ..	3·25	20	·642
Total ..	5·42		1·884
Total II to V	5·38		1·846
CASE B—			
I Over 15 in. ..	·04	95	·038
II 14 in.–15 in..	·05	90	·045
III 12 in.–14 in...	·13	80	·104
IV 10 in.–12 in...	·21	70	·147
V 8 in.–10 in...	·51	55	·280
VI 6 in.– 8 in...	1·23	40	·492
VII 4 in.– 6 in...	2·22	20	·444
Total ..	4·39		1·550
Total II to VII	4·35		1·512

Age 3″—43, 4″—57, 6″—80, 8″—100, 9″—110, 10″—120, 12″—136, 14″—150, 15″—165.

Rotation—

165 years with case A. 5 periods of 33 years.

168 years with case B. 6 periods of 28 years (as Class I and II = ½ classes).

In case A it takes 165–43 years for a 3-in. tree to reach exploitable size = 122 years.

In case B it takes 165–57 years for a 4-in. tree to reach exploitable size = 108 years.

Case A

Annual yield = Number of trees reaching Class I per annum $= \frac{1.512}{122} = .0151$ trees/acre or 9.66 trees/square mile.

Case B

Annual yield = Number of trees reaching Class I per annum $= \frac{1.512}{108} = .0140$ trees/acre = 8.96 trees/square mile.

The growing stock needed to support these yields is as follows:—

$$A: .0151 \times \frac{33}{2} = 0.249$$

$$B: .014 \times \frac{28}{2} = 0.196$$

There is therefore a very large deficit of old trees and to correct this, the proportion of the actual/required G.S. is applied to the calculated yield.

A: $\frac{.038}{.249} \times .0151 = .0023$ trees/acre or 1.47 trees/square mile.

B: $\frac{.038}{.196} \times .014 = .0027$ trees/acre or 1.73 trees/square mile.

The adjustment may be carried out by other methods, e.g. by undercutting 1/33rd of the deficit over the whole period (or 1/28th), e.g.:

$$\text{Yield A} = .0151 - \frac{(.249-.038)}{33} = .0151 - .0064 = .0081$$ trees/acre or 5.2 trees/square mile; *or*

$$\text{Yield B} = .014 - \frac{(.196-.038)}{28} = .014 - .0056 = .0084$$ trees/acre or 5.4 trees/square mile.

The yields calculated from growing stock and increment can be summarized in a table as follows:—

Method	Annual Yield in cu. ft.		Annual Yield in No. of Trees	
	per acre	per sq. m.	per acre	per sq. m.
Based on G.S. only	·225	144	·009	6
Based on Increment	·113– ·180	72– 115	·0046 –·0075	3– 4·8
Swiss Method ..	·14	90	·006	3·75
Austrian Method ..	·1075	69	·0045	2·9*
French Method ..	·114	73	·0048	3·0*
Indian Method ..	·072	46	·003	1·92
Diameter Class ..	·294	188	·0123	7·8
Brandis Class:				
Case A	·194	124	·0081	5·2
Case B	·196	129	·0084	5·4
Approx. Average (8 methods) ..	·162	104	·0067	4·32

*All at 24 c. ft. per tree

Yields Based on Area and Volume

By a combination of the methods described in previous pages a more detailed yield can be applied to an area in which there are known to be differing classes and conditions of woodland. The application of the method, however, entails considerable knowledge of the state of growing stock. For the present time it is probably adequate to divide the area into three quality classes, good, medium and poor, having first deducted all non-productive lands. The quality classes have been described in Part II, p. 190, and are based on the amount of exploitable trees present, not on the whole growing stock. Having allotted specific areas to the quality classes the yields are then calculated by one or more of the volume methods.

Suggestions for Future Yields

It is proposed from experience that yields should be calculated by the combined area and volume method, however simple the subdivision of the area. The volume calculation should be one which uses the distribution of growing stock into girth classes even if only like the French method, i.e. into large, medium and small wood, because the uneven stocking does not warrant the lumping of the growing stock into a single figure. The yield as calculated by the three methods, French, Indian and Brandis', takes most factors into consideration and can be modified very simply in respect of previous fellings, mortality rate and proportion of unusable trees. In calculating yields for the immediate future, it is not particularly desirable to pay a great deal of attention to the small-girth classes, especially as no silvicultural treatment or system has yet been found for this type of woodland. Yet on examination of the yield calculations it will be found that the increment of trees up to nine inches Q.G. provides a considerable part of the calculated yield. With our inadequate knowledge of the woodland and its reproductive powers we are not in a position to admit that this rate of reproduction is guaranteed. We can, however, afford to ignore it, thus allowing it to continue, and to calculate a smaller yield for the larger girth classes which appear to be deficient in volume and which will be influenced by the exploitation over the next 25 years. The proposals for the future are therefore: (i) to divide and allot the whole area into quality classes and non-productive areas; (ii) to enumerate samples in each quality class, of all muninga stems over 8 in. or 9 in. Q.G.

at b.h. (i.e. 9 in. in 3 in. classes and 8 in. if in 2 in. or 4 in. classes), recording any stumps of previous fellings; (iii) to calculate the yield for each class by the three methods proposed above introducing factors for previous exploitation, mortality per cent and unusable timber. Factors of age and increment will be revised from time to time for increment plots within the Province. For the next 10 to 15 years it is suggested that the lowest practical yield be adopted, and the effects of its application be reviewed at the end of that time.

Management of the Woodland

Under present conditions any proposals for managing muninga are virtually proposals for the whole woodland since this one species is almost the only one of economic importance. It may happen that secondary species will again become economic but the danger of their being over-exploited is too remote and too unlikely to happen if effective methods of management are already in existence for muninga. Four stages of management, some overlapping, are envisaged. Firstly, the permanent acquisition of the muninga-bearing woodland; secondly, the stocktaking of the woodland; thirdly, the control of all exploitation by means of controlled yields and defined cutting areas; and fourthly, the consolidation of the forest estate and probably reduction to a permanent minimum.

The First Stage

The woodland exists largely on public lands. The only large areas of permanent reserve are those acquired since 1948. To maintain a large-scale economic proposition on public lands which may in the future become cleared for settlement, grazing, tobacco or other farming is most unsatisfactory so it is suggested that all muninga-bearing woodland be created into forest reserves of at least semi-permanent nature with a provision for future de-reservation of certain areas for settlement, etc., as these become vitally necessary or economically more important than timber production. Nevertheless a basic proportion of the land should be retained as permanent reserves sufficient to produce a minimum specified amount of timber in perpetuity. The main commercial timber areas should be state reserves and those areas providing local supplies should be local or native authority reserves. This reservation programme should be more than half-completed within five years and the balance within the next five years.

The Second Stage

Having acquired some of the forest estate, it is most important that stocktaking should take place in order to determine the yield that can be cut in the next decade and to find out which areas are the best-, medium- or poor-quality woodland and how much of each exists. This can only be done by enumerating samples in as many places as possible. From experience it is recommended that the initial target should be a 5 per cent survey over 50 square miles in each 1,000 square miles of the woodland. In the first surveys all trees under 8 in. may be ignored (unless there is time and opportunity to do more), but all stems over 8 in. in the samples should be measured at least for b.h. girth, timber heights and defects. Girth classes can be in 2-in. groups from 8 in. or 3-in. groups from 9 in. Subsequent surveys after the initial target should aim at including a further 2-in. or 3-in. group each time an area is visited. Most important of all is that the surveys should be analysed and the controlled yields be fixed in the light of current information.

The Third Stage

This stage is that of the application of the knowledge gained in the second stage to the areas acquired in the first stage. Part of this stage is already in being, but instead of being applied to vast areas at a time these areas should gradually be reduced and the yields applied in more detail to specified areas or final reserves. The first target to be set should be separate yields for each 1,000 square miles of woodland. As well as defining the yield in quantity, the management should restrict cutting to defined annual coupes, such coupes can be marked by slashing trees along compass lines or following natural boundaries. The knowledge to be gained during this stage is the actual out-turn per unit of area. Figures must be collected in order to correlate the calculated yield with actual production. In addition it is desirable that statistics be collected to provide yield tables and volume tables. Trees measured for b.h. girth, timber height and defects should be numbered and remeasured for length, mid-girth and defects after felling. During this stage timber on unreserved land should be felled in preference to that in forest reserves and regarded as a salvage measure.

The Fourth Stage

This is one which may not be necessary but in view of the progress of scientific research it must be considered a probability. The total area of woodland put under reservation in stage one should be the greatest possible area that can be acquired. In the fourth stage the area should be whittled down to the better muninga-producing areas, plus such land as requires conservation until a better use can be made of it. The best muninga areas should all become permanent forest reserves, they should include all areas needed to produce a minimum target of production, which at the moment is fixed at 750,000 cu. ft. per annum. With better methods of exploitation and control it may be possible or desirable to raise this to one million but on the other hand further stock-taking may reveal that it is not possible. Two likely factors that may alter the whole economic position of this type of woodland are the overcoming of tsetse fly and the discovery of a type of farming which is very suited to these dry areas, e.g. tobacco growing. Without these factors there seems little to cause the fourth stage of management to become a necessity.

On the silvicultural side there is little that can yet be prescribed. The two steps that would affect distribution and growth are the silvicultural marking of all fellings, and the tending of the young crop (up to 6 in. diameter b.h.). The silvicultural marking of fellings should make sure that sufficient seed-bearer trees remain after exploitation to provide regeneration in areas where it is not up to 10 per cent of the crop. In areas where regeneration is over 10 per cent the main object of the marking would be to ensure that all old trees are removed and that medium-sized trees have full scope for development. The tending of the young crop should comprise pruning, thinning of multiple stems and opening the canopy for crown development. With the restriction of fellings to defined coupes these operations could all take place in the one coupe and probably some of the thinned material could be utilized by the timber exploiter.

Research into the part played by muninga in the present crop and into methods of regeneration should be continued with the object of increasing the proportion and quality of muninga in the total crop. It is probable that this research will entail more attention to what happens at or near ground level and below ground than to the composition of the upper storeys of the woodland. The economics of pruning and tending operations will require investigation to see to which areas they can be profitably applied. The effects and control of fire should continue to be studied to see if they affect regeneration of muninga or other species, water supplies and game distribution. It may also be necessary to study the effects of silvicultural work on the distribution of tsetse flies.

Protection of the woodland resolves itself into two main works, control of fire and control of human activities. In the absence of better knowledge controlled burning should be carried out in areas where human activity is most common, i.e. in felling areas, along highways and byways and around settlements. A mile depth from roads, etc., is advised as a minimum distance to be burned. As regards human activities, in general these comprise encroachment of boundaries, destruction by fire or cutting caused by honey hunters, illicit felling of trees generally and in some areas illicit grazing in reserves. These activities can be suppressed by means of good demarcation of reserves, and good patrol work by the forest staff. These two measures should be adequately catered for in any plan of management.

This report represents a collection and correlation of facts which have been compiled over a period of five years. Considerable progress has been made during that time to get control over the sources of the timber and its rate of exploitation and at the same time find out by what means the crop can be reproduced and improved. Further evidence may prove that some of these data are out of date and not particularly correct, nevertheless it is hoped that the good which comes of the correct information may far outweigh the errors. Considerable information may be available which has not yet come to light; it is hoped that statements in this report will cause others to produce information from their experience and thus further the quest for knowledge.

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THE THIRD FORESTRY COURSE, 1955

The third Forestry course was held in mid-November, 1955, partly at Muguga and partly at Molo. The reason for the courses, which started in 1952, was that extensive touring in the territories by specialists had shown that with many forest nurseries and plantations varying results were being obtained by different methods and similar results by varying methods.

Further, in the E.A.A.F.R.O. forest nursery and experimental plantations at Muguga, the effect of varying local soil and other conditions were beginning to show results. It was thought that in general nursery work throughout the territories could be improved, and that for this a better understanding of the basic principles was needed. Great improvements have been made in nursery and plantation work in the past three or four years, but much still remains to be done. That these courses are much appreciated is shown by the fact that the Forest Research Co-ordinating Committee has not only asked for a fourth course but also for the organization of local district courses.

This third course lasted for a week and started with three days of discussions and practical demonstrations in the E.A.A.F.R.O. Forest Research Nursery and Experimental Plantations. The whole course then moved up to Molo in Londiani Forest Division, and spent two days of practical demonstrations and discussions in some of Kenya's softwood plantations. In previous courses the end of the week consisted of single day excursions from Muguga to see forests of interest, and this change in the third course was made because it was felt that with day excursions too much time was taken up in travelling. The course was attended by 18 forest officers and foresters. One of the delegates came from British Somaliland and another from a Tanganyika Gold Mining Company. This latter is a good beginning, for many of our industries in East Africa such as mining, tobacco, and pyrethrum depend for their existence or processing on wood fuel and poles, and it is seldom that the companies concerned endeavour to make themselves self-supporting in these forest products. We would also like to see some farmers attend the courses, as farm forestry is essential to the welfare of the country and the basis of good farming plantations, windbreaks and shelter-belts, etc., is a good farm forest nursery. Talks were given by various E.A.A.F.R.O. specialists and other outside officers, and to all we are most grateful for their help. The benefits of these courses are great, for they give a chance to groups of technical officers who normally lead very lonely lives, to get together, to know each other and to discuss their problems. These problems are usually interterritorial and without such personal meetings districts tend to become very parochial. Each territory can help the others with their experience and from the E.A.A.F.R.O. point of view, by the discussions and criticisms we get to know a great deal of the problems that need to be dealt with and their priorities. We have not the staff or funds to do all that should be done and from courses like these we get an indication of what work is likely to be the most useful.

The course was voted a great success and the interest in it was shown in the discussion at the final session, and the criticisms and suggestions which were made for the next course. Fifty-two forest officers and foresters have now attended these courses, and we hope to hold the fourth course in November, 1956. We very much appreciate the efforts of all those who helped to make the course a success, both in work and socially. In particular we are grateful to the Chief Conservator of Forests of Kenya and his staff who made it possible to have two such interesting and instructive days at Molo.

As I said at the first course in 1952, the moral of the course is that good nursery work means bigger, better, cheaper and quicker plants and this in turn means better and more regular plantations which are cheaper and easier to tend. This object can only be achieved if the basic principles of the work are understood and applied to local conditions.

A. L. GRIFFITH.

REVIEWS

FRUIT, 1955, published by H.M. Stationery Office. Price 5s. (5s. 4d., post free). Obtainable from the Secretary, Commonwealth Economic Committee, 2 Queen Anne's Gate Buildings, Dartmouth Street, London, S.W.1.

With production continuing to expand, and some easing of trade restrictions, world exports of both fresh and canned fruits in 1954 were the largest ever recorded and those of dried fruit the heaviest since the war. The Commonwealth Economic Committee's annual review *Fruit, 1955*, shows that exports of fresh fruit totalled 7,000,000 tons, or 1,000,000 tons more than in 1952 and 1,500,000 more, on average, than in 1934–38. Exports from the Commonwealth were also at a high level, particularly those of canned fruit, which established a new record.

United Kingdom imports of fresh and canned fruit showed a further recovery in 1954, from the low level of earlier post-war years, and while imports of dried fruit were somewhat reduced, raisin and currant supplies were above average. Commonwealth sources provided 83 per cent of the total receipts of canned fruit in syrup (as against only 40 per cent in 1938), 68 per cent of the fruit juice, 51 per cent of the fresh fruit, and 20 per cent of the dried vine fruit.

Although United Kingdom imports of fresh fruit in recent years have been smaller than before the war, total supplies in the United Kingdom have not been greatly reduced because of the increased supply of home-grown fruits. Fruit consumption in the United Kingdom, including processed fruit in terms of fresh fruit, amounted in 1954 to 123 lb. per head, which was nearly 8 lb. more than in 1953 and almost up to the pre-war figure. Consumption in Australia is now somewhat lower than before the war; there has, however, been a marked change in Canada, the 1954 figure for which was 161 lb., as against a pre-war annual average of only 103 lb.

Fresh Fruit.—The further expansion of the international trade in fresh fruit in 1954 was largely the result of heavier exports of bananas; there was some increase in grape exports, but little change for citrus fruit and a decline for both apples and pears. The Commonwealth provided larger supplies of each of these fruits, with oranges nearly double the pre-war average and bananas showing a further recovery; Commonwealth exports of apples, although heavier than in recent years, were still 30 per cent less than before the war owing to the much-reduced shipments from Canada.

The smaller trade in apples in 1954 was due mainly to the lower purchases of Western Germany, the leading market since 1951. The United Kingdom received increased consignments from Australia, New Zealand and South Africa, and small supplies from Canada; the apple exports of each of these countries showed some expansion, those of Australia rising to the 1938 level. World exports of oranges were maintained at the previous year's record total of 2,250,000 tons, notwithstanding severe frost damage to the crop in Spain, which reduced exports by about 20 per cent; this fall was offset by increased supplies from most of the other principal sources, particularly Israel. South African exports created a new record. Cyprus was again the second largest Commonwealth exporter of citrus fruit. While United Kingdom purchases were reduced to some extent, and were well below those of 1938, the imports of France, Western Germany, Netherlands and Sweden all showed further increases to well above their pre-war levels. The marked expansion of the world trade in bananas has been due very largely to increased exports from South and Central America. Jamaican exports, however, have recovered from the hurricane set-back in 1951 and there has been some increase in supplies from Nigeria, Dominica and other Commonwealth sources. While the United States, by far the most important importer of bananas, has not increased its purchases in recent years, there has been a marked expansion in the imports of most Western European countries.

Canned Fruit.—Canned fruit production in all Commonwealth countries except Malaya was at record levels in 1954 and with a near record pack in the United States the world output was 2,250,000 tons, or nearly 250,000 tons more than in 1953. Exports from the leading Commonwealth sources and the United States all showed appreciable increases; shipments from Australia and South Africa established new records and altogether Commonwealth sources provided nearly half of the supplies entering international trade. Imports

into the United Kingdom in 1954 (which was the last year in which they were controlled) were as much as 80 per cent greater than in 1953 and almost as heavy as in 1938.

Fruit Juices.—With a 15 per cent increase in the United States, by far the largest producer, the world output of fruit juices in 1954 rose to about 570,000,000 gallons. Commonwealth countries—mainly the West Indies, South Africa and Australia—contributed over 20 per cent of world exports. Canada and the United Kingdom were again the leading importers and took more than all other countries together.

Dried Fruit.—World exports of raisins and currants increased slightly in 1954 in spite of some reduction in the size of the world crops and of lighter shipments from Australia and the United States, the latter being offset by heavier consignments from Greece and Turkey. United Kingdom purchases of raisins, though smaller than in 1953, were at the same level as in 1938, and those of currants nearly 25 per cent greater.

Wine.—World wine production in 1954, estimated at over 4,600,000,000 gallons, was somewhat smaller than in 1953, but exports were increased by larger consignments from Algeria and Spain. United Kingdom imports exceeded 12,000,000 gallons, the highest figure recorded since the war. Shipments from South Africa were nearly up to the peak level of 1951, but exports from Australia remained comparatively small.

DAIRY PRODUCE, 1955, published by H.M. Stationery Office, Price 5s. net (5s. 4d. post free). Obtainable from the Secretary, Commonwealth Economic Committee, 2 Queen Anne's Gate Buildings, Dartmouth Street, London, S.W.1 or from H.M. Stationery Office.

The upward trend in world production and trade in dairy produce, which continued in 1954, was checked in 1955 when milk production in Europe was affected by the poor grain and hay harvests of the previous year and later by a prolonged spell of hot, dry weather, according to a review published by the Commonwealth Economic Committee. A general decline in cow numbers has also been evident and there are signs of a switch from dairying to beef in several countries, but the effect on milk production levels is being offset by rising milk yields which stem from various technological improvements in pasture management and breeding. Commonwealth countries have increased their large share of the dairy produce entering world trade, following a record season in Australia. The level of international trade in future years will be affected by the possibilities of an increase in liquid milk consumption in the more developed countries, under pressure of rising populations and other economic and social factors; in recent years milk consumption levels have tended to decline although remaining much higher than in 1938, as, for example, in the United Kingdom where consumption amounted to 32½ gallons per head in 1954 compared with 21 gallons before the war. In under-developed countries, including many in the Commonwealth, the growth in purchasing power has led to significant increases in consumption of condensed milk and other milk products.

Butter and Margarine

The marked increase in Australian production in the 1954–55 season and the recovery in New Zealand output raised the Commonwealth's share of world butter production in 1954 to 22 per cent. Commercial exports of butter fell slightly in 1954 and a further reduction has taken place in 1955 following the decline in European production. With the gradual ending of Government trading, movements in supplies and prices have had an increasing effect on butter consumption in the United Kingdom. In 1954 consumption of butter exceeded 14 lb. per head, 1 lb. heavier than in the previous year but 10 lb. less than in 1938, while margarine consumption, which also rose in 1954, was about 8½ lb. above the pre-war level. The evidence for 1955 suggests quite a marked increase for butter and a decline for margarine; the improvement for butter followed a downward trend in prices which was reversed in the late summer when a seasonal fall in Danish supplies, accentuated by the dry summer and a strong demand from other Continental countries, coincided with a rise in consumption.

Cheese

A decline in cheese prices on the United Kingdom market in 1954 and the early months of 1955 has led to a reduction in output and exports in most Commonwealth countries, while in the rest of the world the upward trend has continued. Thus, the Commonwealth accounted for one-third of world cheese

exports in 1954, compared with nearly half in the four years before the war. The level of imports of cheese into the United Kingdom in 1954 and 1955 has been the lowest since 1919, but the increase in United Kingdom production over the pre-war level, together with a substantial reduction in stocks has been sufficient to maintain cheese consumption close to 10 lb. per head. Cheese prices rose markedly in the second half of 1955, but production in New Zealand and Australia, the main sources of United Kingdom imports, has declined further in favour of butter and its by-products.

Condensed Milk

World trade in condensed milk showed a downward trend between 1951 and 1954, but has increased again in 1955, the main factor being the rapid expansion in exports from the United Kingdom. At the same time United Kingdom imports have fallen to a very low level and there has been a corresponding decline in the export trade of other Commonwealth exporters. Malaya and other Colonial Territories have a substantial import trade in condensed milk which more than doubled between 1938 and 1954.

Milk Powder

Production and exports of milk powder reached record levels in 1954, the main factor being the expansion in the supply of skimmed milk powder in the United States under the stimulus of the price support programme. Normal commercial exports, of which Commonwealth countries are the main sources, declined in 1954, but the United States has increased its export trade mainly through Governmental transactions at concessional prices or by free donations. By the end of 1955 stocks of skimmed milk powder were at low levels and prices had risen well above those prevailing a year earlier. While the United Kingdom has remained the largest commercial market for milk powder, imports have shown a marked rise in India where skimmed milk powder is used for reconstitution into liquid milk under various official schemes.

Eggs

Although United Kingdom imports have continued to decline, the strength of the demand for imported eggs in Western Germany has brought world trade in eggs above the pre-war level; in 1954 Western Germany imported nearly twice as many eggs as the United Kingdom, a reversal of the pre-war position. The fall in United Kingdom imports has been offset by an upward trend in output, which in 1954 accounted for 87 per cent of total supplies. Shipments from Commonwealth countries in 1954 were twice as great as in 1938 although they accounted for only a small proportion of total export trade.

MEAT, 1955, obtainable from H.M. Stationery Office, or from the Commonwealth Economic Committee, 2 Queen Anne's Gate Buildings, Dartmouth Street, London, S.W.1. Price 5s. net (5s. 4d. post free).

The upward trend in world meat production continued during 1954 and a further increase has been recorded in 1955 according to *Meat, 1955,* a review published by the Commonwealth Economic Committee. Since 1938 world output has risen by over one-third, a rate of increase fully shared by Commonwealth countries, where technological improvements such as the increased carrying capacity of pastures through better management, improved grass strains and control of rabbits, have played a significant part; these factors are likely to contribute to a further rise in production although some tendency towards marketing stock at lighter weights has become evident in the past two years. Much of the increased output has been consumed in the producing countries but in 1954 world trade in meat regained the pre-war level, the reduction for beef and bacon being offset by increased exports of other types. Commonwealth countries have continued to account for a large proportion of the carcass meat entering international trade, New Zealand being the world's biggest exporter while the United Kingdom imports more meat than the rest of the world combined.

Production and Trade

Ouput of beef and veal in the main producing countries, which rose by 6 per cent during 1954 to a figure nearly 50 per cent greater than pre-war, is estimated to have risen further this year. Exports of carcass beef were still one-third less than in 1938 as a result of greater consumption in the producing countries, especially those in South America which accounted for little more than one-quarter of world exports in 1954 as against three-quarters before the war. On the other hand, Commonwealth countries contributed over one-third of the trade in beef during 1954 as against only one-quarter in 1938. Last

year, too, for the first time since before the war, United Kingdom imports included a fairly high proportion of chilled as well as frozen beef and there was a strong demand from Russia and Czechoslovakia, whose imports of beef exceeded 65,000 tons, a level not since maintained.

World production of *mutton and lamb,* which had shown little change in 1953, rose slightly in the following year when output in the United Kingdom and Australia increased appreciably. New Zealand accounted for a substantial part of the 7 per cent increase in world exports during 1954 and the Commonwealth share of the United Kingdom import market rose to nearly 90 per cent but this proportion has declined in 1955 as a result of a recovery in supplies from Argentina.

There was some increase in world *pig-meat* output during 1954 after the sharp reduction recorded in the preceding year and this continued in 1955 owing to greater output in North America. There was, however, a decline in the United Kingdom, where production reached a record level of 685,000 tons last year, and in Denmark. Slightly larger pig-meat exports in 1954 were attributable to a further expansion in the pork trade; with the decline in Canadian shipments, Commonweath countries now supply only a negligible proportion of bacon exports while not more than one-fifth of the total trade in pork is of Commonwealth origin as compared with nearly one-half in 1938.

World *canned meat* output also recovered from the heavy decline recorded in 1953 and exports, especially from South America and Continental Europe, increased markedly in 1954.

Prices

Meat prices in many producing countries in 1954 and 1955 have risen faster than the prices of some other primary products. In the United Kingdom prices of all types of meat have advanced, but the margin between fresh and frozen beef has widened appreciably. Although most controls over production, consumption, trade and prices ended in the United Kingdom during 1954, the Government continues to be the sole importer of bacon and hams. However, Government support of fatstock prices is still usual in many countries and a summary of these controls and marketing schemes in the main producing countries is given in an Appendix.

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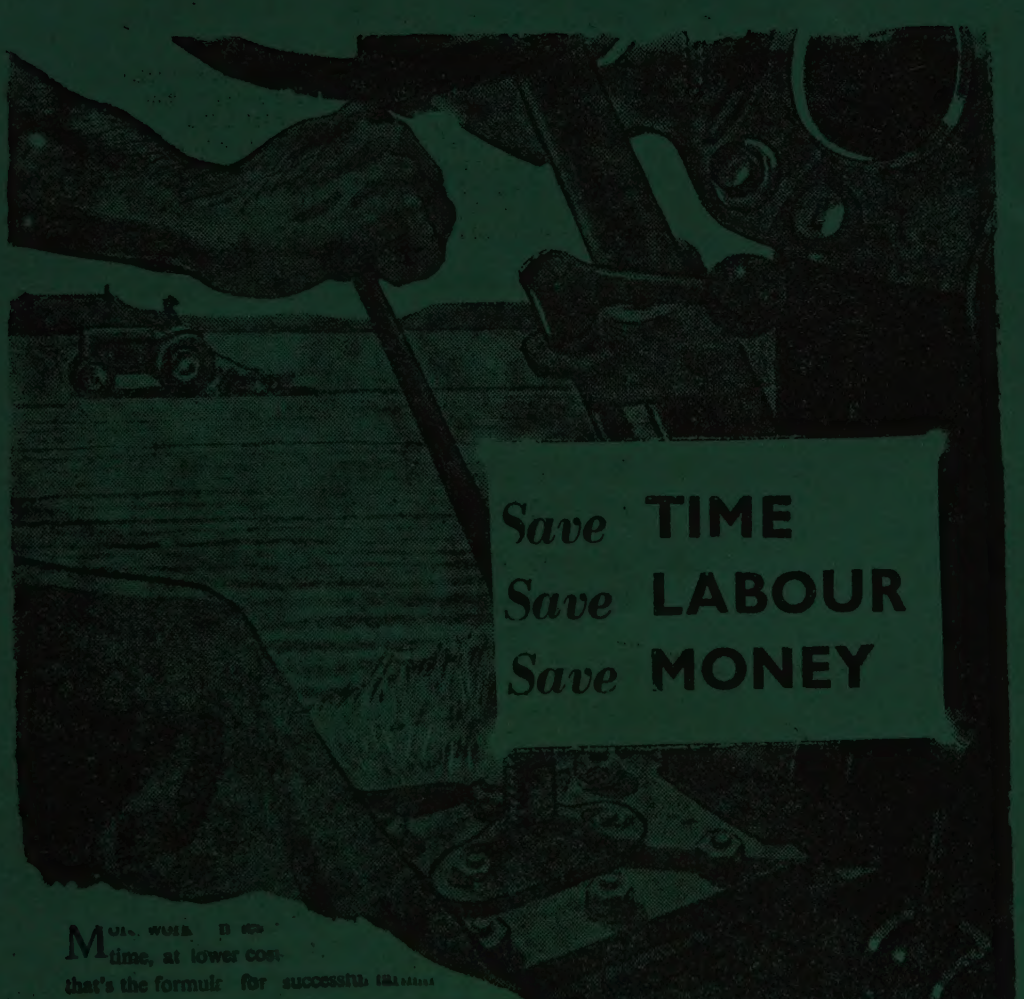

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